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ANNOUNCEMENTS.

FEILDEN'S MAGAZINE is published at the *beginning* of every month.

In consequence of the large number of pages to be prepared and passed for press, the careful nature of the printing required for high-class production, the advance arrangements made for extensive circulation, and in order to facilitate departmental business, observance of the following rules is necessary :—

Literary Matter to reach the offices not later than the 1st of the month (as much earlier as possible) previous to date of publication. Communications to be addressed to "Editorial Department."

Advertisements intended for insertion in next issue must be received not later than the 15th of the month (as much earlier as possible), to insure correct classification. All communications respecting same to be marked "Business Department." Advertising Rates, on application, regulated according to positions available.

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For Buyers' Guide, Index to Advertisers, and Directory of leading British Manufacturers, see pages ii. and iv. of second cover, and pages iii. to xiv. (in first part of Magazine).

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The Title-page and Index to Volume II. are now out of print. If sufficient applications be received the question of reprinting will be considered.

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THE EDITOR will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer.

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Trade Within the Empire.

"*Foreign nations are raising, one after another, a wall, a brazen wall of Protection around their shores, which excludes from their markets, and are doing their best to ruin our Trade.*"—LORD SALISBURY: Extract from Speech.

Those who glance through the extensive array of advertisements that appear in FEILDEN'S MAGAZINE will find that section of the journal characterised by a feature they will seek in vain in any similar publication; there is not to be found in it a single foreign advertisement. FEILDEN'S MAGAZINE does not accept them.

We may perhaps be justified here in referring once more to a matter that was touched upon in our last issue. A well-known English house, whilst recognising the praiseworthiness of a policy we have sufficient reason to deem an unselfish one, complained some time since that, whilst debarring formal advertisements of foreign manufacturers from our pages, we apparently had no objection to advertise their productions in another way, viz. by the description of any invention or improvement which had become notable abroad. This objection is one of a very short-sighted character. Technical details, illustrations and drawings of foreign invention and improvement whenever evidenced, we conceive it the duty of every progressive and liberal-minded organ of scientific and mechanical arts to provide for the information of its readers. But though we may describe the inventions of our rivals, we refuse to become the means of advancing their interests, and cheerfully sacrifice a material addition to the revenue of this journal in carrying out this feature of the policy on which it was established.

That policy—an absolute preference to British manufactures—is now opening out to a very wide horizon, and forecasts what will possibly prove to be the most important development in the whole history of British manufacturing industry. The three great manufacturing nations, Britain, America and Germany, have introduced the means of industrial production on a colossal scale, and their outputs have grown so rapidly as to be now far in excess of the needs of their own populations. The congestion so produced has been relieved by exporting their superfluous commodities to outside consumers. Export trade necessarily takes the line of least resistance, and as our rivals have been shut out from each other's territories by mutually hostile tariffs, the market for their superfluous products has been necessarily provided in a limited degree by their own colonies, but chiefly by Great Britain and the Colonies of the British Empire.

With the single and doubtful exception of China, British colonies and British dependencies are destined to form the future export markets of the world. It is on these that the attention of our rivals is so eagerly concentrated. Canada, Australasia, and that centre of gigantic possibilities, British Africa, are the lands of golden promise to the manufacturers of the Continent and America, and on their at least partial possession of these their future existence as exporting nations must stand or fall. And of these markets, so coveted by our commercial antagonists, even the boundless prospects of Canada, with her vast uncultivated plains, that a few years will see teeming with rich grain fields—of Australasia, with her multiplying flocks and herds—fade almost into insignificance beside the grandiose future that awaits the development of the Dark Continent.

British Africa, since the absorption of the two Southern Republics into the British Empire, comprises, if we include Egypt, a territory of some 3,300,000 square miles, which cover the richest area—that from north-east to the south—of the Continent. The natural riches that lie untouched in this area are incalculable. In gold, diamonds, iron, coals, copper, and tin, British Africa is accounted the richest land on earth. In a recent Report on the Cape to Cairo Railway, made to the United States Government, the writer says:—

"The line of the railway will pass the great coal beds of the Zambesi, near Tete, and the enormous iron deposits of Lake Tanganyika region. Here furnaces will no doubt spring up and huge ironworks be established, supplying nearly all Africa. Magnificent

forests of timber exist from Zambesi to the Nile. Water-power can be obtained everywhere. Undoubtedly Africa has the finest water-power system on earth. What Niagara is to America, Livingstone Falls, Stanley Falls, Murchison Falls, and Victoria Falls are to Africa; and these are not all. . . . Asia, China, Japan, India periodically starve for food. America will soon eat all she produces. Africa is capable of production from Tunis to Cape Town, from Guardafui to Cape Verde. The African is the best agricultural labourer in the world. Africa is to be the garden of a hungry earth. . . . Africa is probably the richest mineral continent of them all. Besides the Kimberley and Johannesburg gold and diamond mines, other similar deposits are being constantly found, and copper and iron smelting operations have been carried on for centuries by the natives in the very country this railway (the Cape to Cairo) proposes to open up. The whole Congo-Zambesi divide is probably one enormous coal-field. . . . What form this mighty empire will assume depends largely upon England's attitude. As to the other Powers, their attitude perforce will be one of co-operation. The Englishman is entirely satisfied so long as he is allowed to lead. Enlightened public opinion in England will finally settle down upon the policy of digesting and assimilating the vast regions thus brought under sway, and allow the other nationalities to do the same with their smaller portions. The predominant English influence, however, will gradually pervade the whole, and practically, if not formally, the Continent will be more Anglo-Saxon than America."

Just at that point when the might of British arms has achieved the consolidation of this vast Empire, and a practically uninterrupted line of British territory from the Mediterranean Sea to the Southern Indian Ocean established, the Australian Colonies have also achieved their consolidation by mutual federation. We are informed that one of the first steps of the Australian Commonwealth will probably be to follow the example of the Dominion of Canada, and offer a preferential tariff to the products of the Mother Country.

The enormous importance of such a course cannot be over-estimated. We are surrounded, as Lord Salisbury has said, by a brazen wall of hostile duties. Our former consumers have become our competitors, and they evince little signs of generosity in their dealings with us. It is an ungrateful task for us to continue to fight against the bulwarks erected against us, and we would do well to divert our energies in another direction. Even under the equal opportunities offered by our Colonies (except Canada) to others with ourselves, our Colonial trade *per capita* is immensely out of proportion to that we do with the peoples of the European Continent and the United States.

As a matter of fact it has been computed on the authority of figures which at the present time have so increased as to accentuate the illustration, that one Australian is as large a customer as sixteen Americans, and every Canadian worth more to us than thirty-five Russians. Why, then, not keep these markets to ourselves? "Free trade within the Empire" is an ideal that may not yet be capable of realisation, seeing that the undeveloped countries require to raise a revenue for national necessities, which can only be satisfactorily accomplished by indirect taxation. But Preferential Tariffs have already been proved, not merely practicable, but a success, and a system that requires only to be extended to prove of incalculable benefit to the Empire.

A material object-lesson as regards the importance of this question will probably be afforded in the fiscal system applied to the late Transvaal and Orange Free State. The trade of these two provinces amounted before the war to some £35,000,000 annually. Judging by the preparations that have been made abroad, it appears to be assumed that these territories, reclaimed at such a cost by this country, are to be thrown open to its rivals without any sort of compensation to their conquerors for the enormous risks and losses they have sustained.

It is not possible to forecast the exigencies of international diplomatics; but should our American and German friends be able to carry out the programme they appear to have settled on, and crowd the Transvaal and Orange River Colony with their manufactures, to the material detriment of British products, a certain semi-classic fable will have been illustrated on a scale worthy of an epic.

South African Bridge Contracts.

SOME further news would be decidedly interesting as to the policy to be adopted by our colonial authorities with regard to the erection of railway bridges in South Africa. Public opinion has been somewhat exercised by rumours that contracts for railway plant have already been placed in the United States, and more than one writer has suggested that British contractors should be favoured merely on patriotic grounds. We thoroughly agree with this sentiment, but the manner in which it is very frequently stated implies a serious misconception as to the true facts of the matter, and an injustice to British bridge builders.

There appears to be a general impression that bridges can be made in America much cheaper and much quicker than in this country, and those who entertain this view are apt to compare lightly made American bridges of the pin type with the more massive structures of our own engineers. Although every credit may be given to our transatlantic cousins for their excellent methods of standardisation as applied to constructional work and to the production of designs, the fact remains that a vast difference exists between the practice permitted in this country and that which obtains in the United States. Strength and durability have always been distinguishing features of British engineering work. Even when exemplified in steam engines and in machine tools of simple types, these qualities have proved to be of great advantage in spite of what is sometimes said to the contrary, and they are still more desirable when evidenced in permanent structures such as railway and other bridges.

As proving this contention, we have only to mention such admirable examples of sound, honest work as the Newcastle High-level bridge, the Britannia and Conway tubular bridges, and the Saltash viaduct. These magnificent works remain, perhaps not as models of modern design, but as incontrovertible proofs that ephemeral structures are by no means so essential as some people would have us believe. The adoption of a high standard of strength has always been insisted upon, both by the Board of Trade and by engineers, ever since the introduction of the railway system, and before the opening of any bridge for public traffic rigorous tests must be successfully endured, so that ample safeguards shall exist for the benefit of passengers. A similar practice was followed with regard to the original equipment of the Cape and Natal Government railways, and those lines are consequently representative of the best class of workmanship and design.

Turning now to American practice, we find a very different state of things, and although signs of improvement are not wanting, the fundamental idea of the American engineer appears to be to make everything light, so that it may break up in the course of a few years and be replaced by something of newer design. This sort of "jerry-building" was formerly characteristic of most American manufactures, and a few months ago it was especially recommended as worthy of adoption in British engineering practice by a traveller who had then recently returned from the United States. As an instance of the difference to which we refer, we may state that in 1882 the manager of a shop in Maine said: "I have an English tool here which is the best tool in the whole workshop, and when I have any accurate work to do I send it to that lathe."

The machine in question was one of Whitworth's old lathes, and it was then still worked by the best man in the shop, and did the best work. The beds of the American lathes were not so strong, and would not turn out work so accurately, but since that time it is undoubtedly the fact that American machine tools have been much improved so far as stiffness is concerned. Of course, we fully admit the excellence of workmanship and design which is displayed by machines produced in the United States, and our present point merely relates to the general predi-

lection for things which will not last for any great length of time.

This is well known to extend to bridges for railway work, which are of light construction and made with the view of possible replacement; and it should be remarked that the practice is not discouraged by the existence of any severe Government restrictions such as those imposed upon British railway engineers. The pin type of bridge is peculiarly American, but it is not to be recommended for railway traffic. A well-known American engineering journal mentions the comparatively recent demand in America "for a railroad bridge structure embodying the highest perfection of strength and stiffness, and making a continuously solid roadbed, over which trains may run at the highest speed without being obliged to be merciful to the bridge." With the last-quoted definition we are heartily in accord, and it is to be hoped that our colonial authorities will insist rigorously upon the attainment of such conditions in all new structures for which tenders are to be invited. In that case we have not the slightest doubt but that British firms will be fully able to hold their own, both as regards prices and dates of delivery.

Iron Trade and Ship-Building Prospects.

To many people it may appear absurd for us to say that the prospects in the iron trade are very bad, while the prospects in the ship-building industry are very good. The one trade is so much bound up in and dependent on the other, that prosperity or the reverse would seem to be necessarily reciprocal. Again, it may surprise some readers that we should say the prospects in ship-building are good, after the publication of Lloyd's returns for the quarter ending 30th September, and of the comments thereon by the oracles of the daily newspapers. But things are not usually what they seem, and the ready writers who periodically make "copy" out of the publications of Lloyd's and of the Board of Trade, are not usually acquainted with the qualifying facts which materially alter the complexion of the figures.

Let us look for a moment at the returns of *Lloyd's Register of Shipping*, on the ship-building work of the quarter. According to this paper there were 452 merchant vessels, of an aggregate of 1,204,008 tons, under construction in the ship-yards of the United Kingdom on the 30th September last. This does not include war-ships, either in Government Dockyards or in private yards.

With regard to war-ships it is to be noted in passing that they are even more important from an industrial point of view than merchant-ships, because they absorb more material and labour of the highest class per ton. As regards merchant-ships, however, the figure just stated compares with 1,347,549 tons at the 30th September, 1899, and therefore marks an apparent decrease in the work on hand of about 143,500 tons. But Lloyd's figures relate only to vessels actually "under construction." Now it so happens that while very little contracting for new vessels took place in the first half of the year, a demand began to revive in July, which became very active in August and September.

In these two months the Clyde ship-builders alone booked fully 150,000 tons of new orders, and the ship-builders of the North of England booked orders computed at 100,000 tons. Here, then, are a quarter of a million tons of ship-building work on hand, very little, if any, of which can be included in Lloyd's figures, simply because there was not time to lay the keels before the 30th Sept.—even where there were vacant berths ready, which certainly was not in very many yards. We put it then, that there were really something like 1,500,000 tons of ship-building work of merchant-vessels on hand at the end of last quarter, though not all "under construction," and that to this large total has to be added about

500,000 tons of war-ship work actually on hand, and some 40,000 tons of new cruisers, the contracts of which have just been placed while we write.

This is an immense record of work, and it is not of much consequence whether the sum total has been slightly exceeded on any previous occasion in recent years. Our point is that the work on hand is very much larger than it was in May, and therefore that the conditions of the trade have improved. With contracts that will keep practically all the yards actively employed for at least twelve months, and some of them for longer, we are warranted in saying that the prospects are good. But they are better still than these figures show, because there is every reason to believe that the demand for new ships is by no means appeased.

There seems to be a distinct scarcity of sea tonnage, which can only be partly ascribed to the employment of vessels in the service of the South African war. The high price of material has restricted building in other countries besides this, while all the time what may be called the natural wastage of shipping has been going on. The great mail and passenger companies have been renewing their fleets, as they must always do; but the owners of cargo-carrying boats—freight-steamers, as the Americans call them — have been holding back in uncertainty as to the future of freights, and in alarm at the high prices that builders have been compelled to ask in consequence of the great advances in structural material, wages, and coal.

But prices of material are now steadily coming down, and while they have been up, large numbers of owners have seized occasion by the hand and sold out their holdings at a handsome profit. Thus, we have heard of a 4,000-ton boat sold recently for £40,000, which, three years ago, cost £28,000; of a 3,000-ton boat sold for £30,000, which, two years ago, cost £24,000; of a 6,000-ton boat which, in 1897, was valued at £35,000, recently changing hands at £50,000, and so on.

Last year British owners sold to foreigners some 610,000 of second-hand vessels, and this year they have been selling at a rate which promises to show a considerably higher total. On all these sales handsome profits have been realised, and the sellers can now afford to replenish their fleets even at the high prices hitherto current. Many of them have been waiting just to see if top had been reached before putting out their specifications; and it is significant that by far the greater portion of the contracts recently booked are on account of British owners.

That top has been reached, there is little room to doubt. That the downward movement has begun, there is every reason to believe. Steel ship-plates, a while ago at £8 10*s*., are now being offered by Scotch makers at £7 15*s*., and have been sold considerably lower. This is a substantial reduction, but as a matter of fact, Scotch makers are not obtaining orders at the reduced price; they are being undersold by America, and thousands of tons of American steel plates have been delivered, and thousands more sold for delivery ahead, to Clyde ship-builders down to and it is said even under, £7 per ton. Whatever the actual price up to this time, it is certain that the competition between Scotch and American makers for orders will bring it still lower; and it is not improbable that the price of ship-building material may be down to the level of 1898 before the winter is far advanced.

While this will be for the advantage of ship-builders and ship-owners, it will not be for the iron trade. The plain fact is that more iron and steel are now being produced in the world than the world can consume. The productive capacity of the United States and Germany has been, during the last two or three years, increased to an enormous extent, and reached its fullest development just when consumption began to decline. In every other department of industry, except ship-building, the prospect at present is of growing contraction. In every department of production in iron and steel, the prospect is of increasing difficulty to find an outlet.

The manufacturers of the United States and Germany are at their wits' end to find markets for their surplus

make. The Germans have invaded Belgium, and swamped the Belgian trade. The Belgians are driven to compete vehemently with the Germans for Continental and British orders; and the Americans are pushing their stuff all round—not merely, be it observed, to get rid of surplus make, but also with the object of building up a steady export business.

In such circumstances as these, with wages and coal at the highest prices known for nearly thirty years, the prospects cannot be considered good for the British iron trade. And manufacturers have also to reckon with pig-iron at a higher price than it would otherwise have been by this time but for the phenomenally small stock in the country. Pig-iron will become cheaper, of course, as coal recedes, and coal has begun to recede. But it is not likely that coal will come down quickly, situated as coal-owners are with high-priced contracts, and also with high wage agreements fixed for several months to come.

Meanwhile, American pig-iron is being dumped into the very heart of the English malleable iron trade; American steel bars into the very heart of the Welsh tin-plate trade; American blooms and billets into the very heart of the steel manufacturing trade; and American ship-plates into the very centre of the shipbuilding trade. It is not necessary to credit all the sensational stories told by newspaper correspondents about the designs of the Carnegie Steel Company; neither is it prudent to hang on the words of those who enlarge on the comparative smallness of the exports of iron and steel from America as revealed so far by the official lists. The Carnegie Company cannot do all that they are credited with the intention of doing; and the actual shipments of American material in the past are of small importance compared with the probable shipments of the future. It does not need a large quantity of stuff to break a weak market; and why we say the prospects of the iron trade are bad is because prices are bound to come down more rapidly than costs, under declining consumption and increasing competition.

Points Suggested by Prof. Perry's Recent Address.

We had occasion in a recent issue to refer to the good work that Professor Perry had done for the cause of technical education by the introduction of his new method of teaching mathematics in evening classes in science schools throughout the country. The Professor is always on the alert, and watches signs of the times very closely. He is absolutely alive to the importance of real scientific work, and to the value of modern methods. In his inaugural address, delivered at the Institution of Electrical Engineers, he did not, in making a forcible appeal for an application to their duties freed from rule of thumb and effete methods, spare members of the profession represented by that Institution.

The essential point in the opening portion of his address was the danger that the Institution ran of recrudescing into a mere trades union by the fact that the tendency existed for electrical manufacturers to use ordinary types of machinery or electrical plant in well-known ways, and this tendency was strengthened by the habit engineers were falling into of thinking that every new installation required practically the same treatment as existing ones.

It must be confessed that this danger, which may apply almost with equal force to mechanical engineers, is not imaginary, and is one of the real menaces that the system of standardisation may have in store, in spite of any compensating advantages.

With standard patterns, standard dynamos, engines, locomotives, and what not, the tendency will be to cause an engineer to seek to adopt an existing type rather than go to the expense of designing something entirely new, although such a course might result in effecting a higher efficiency, and would, at the same time, call into play all the experience and all the knowledge possessed by him.

It is, as Professor Perry pointed out, in this regard that the electrical engineer stands in contradistinction to his brother of the Civil Institution. The latter is not to the same extent in danger of lapsing into a groove through the advent of standardisation; in every new harbour, canal, railway, or even bridge, he is confronted with difficulties that have never before presented themselves. To quote the Professor, "An engineer who designs many undertakings, and sees them carried out, must be a thoughtful man; he cannot help keeping himself acquainted with engineering principles, and so he is a professional man. So an architect finds that each new job requires all his experience. Every case that comes before a real physician or surgeon requires somewhat different treatment from any old case. Every case brought before a barrister requires the exercise of all his past experience. In every case a *profession* implies the necessity for the exercise of all one's past experience, because the work one has to do is never the same as any work one has ever done before."

In thus freeing the members of the Institution of Civil Engineers from the menace which threatens members of allied bodies, their governing body cannot be absolved from what is really a somewhat narrow-minded prejudice. Laid down as they have been by the very flower of the engineering profession, the carrying out of the principles of the premier Institution exhibit a flagrant inconsistency in the prohibition of membership to contracting railway or harbour engineers. Surely as much foresight, ability, and experience are needed in the carrying out of works in which the rectification of mistakes, or the alterations necessitated by local conditions, in the plans made by the consulting engineer, are of frequent necessity?

Fortunately for the Institution which Professor Perry addressed, the framers of the conditions of membership were broader-minded, and from the first admitted manufacturers, contractors and their employés. We are glad that the Professor drew particular attention to this point, not that we can hope for the older and more conservative body to be greatly affected thereby. The totally unnecessary idea of such strict exclusion and limitation is not a characteristic of the Institution of Civil Engineers only, it would seem to refer generally to those bodies who are in possession of a charter. In particular may be instanced the Institute of Chartered Accountants. With all due regard to the public protection which is guaranteed by the existence of such bodies, an invidious distinction is suggested between members and those who may be practising in an equally efficient manner, but who, nevertheless, do not see their way clear to register their qualifications by the examination system. We are glad to observe that Professor Perry did not suggest this method of admitting any kind of members to the Institution of Electrical Engineers, as its adoption would certainly not have insured the admission of those "whose theory is so much a part of their mental machinery that is always ready for practical application to any problem," which definition represents the Professor's idea of a real engineer.

The fact of a man having passed an examination in theoretical subjects would not insure that thereafter he would not become indolent, or that he would keep himself abreast of the developments which took place. Men of real ability and character, taking an intelligent interest in their profession, in other words successful men, are they who do watch theory closely in spite of examinations; the very idea of their being successful presupposes it.

Standardisation presents little or no danger to such men; their individuality would always be stamped on their work in some form or other; ambition alone would save a number from degenerating into mere "tradesmen." Examination or no examination, the indolent, the incapable, the unambitious, must always fall away in the race, and it is not to be doubted that men engaged in civil engineering are left behind in exactly the same way and for just the same reasons as their unfit brethren engaged in electrical industries.

"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilization's timepiece put back 200 years."—RT. HON. LORD CHARLES BERESFORD, C.B.

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Handbooks of Steel Sections . . .

UNDER the above heading, we made some comments in our issue of September last as to the utterly inadequate nature of the information contained in ordinary section books. Whether the criticism in question is responsible we do not know, but it is gratifying to record the publication by Messrs. Redpath, Brown & Co., Ld., of Edinburgh and London, of a very carefully compiled handbook of steel girders and columns, in which the calculations, diagrams and explanatory remarks have been made by Mr. Alexander Drew, M.I.Mech.E. The book is divided into two parts, the first dealing with joists and girders, and the second with columns. At the outset it is explained that all steel supplied can be manufactured by the Siemens-Martin or the Bessemer process at the option of the purchaser, and to conform with those standards which are accepted by the Admiralty and Lloyd's inspectors, certificates of strength being furnished from the rolling mills, or taken there under personal supervision as required. The tables of strength of joists and girders are based on a maximum safe stress of 7 tons per square inch, or a minimum factor of safety of 4. These preliminary reservations are important, because many of the tables published by merchants relate to foreign steel, of which the exact strength is not divulged, and the so-called safe stress not infrequently runs up to more than 10 tons per sq. in. As girders are sometimes required for work of a temporary nature, in which deflection is not in itself objectionable, it is pointed out that a lower factor of safety may occasionally be employed. On the other hand, when structures are subject to considerable vibration, it is advised that the factor should be increased to 5 or 6. Simple directions are given for adapting the tables to such special conditions. The first series of tables in the joist and girder section of the book give general particulars and safe distributed loads in tons for various spans, based on the safe stress of 7 tons per sq. in., and, we may add, with ends supported, a condition which the publishers might, perhaps, have printed more conspicuously. The second series of tables in the same section gives the following particulars of similar joists and girders:—Overall depth and breadth; detailed list of bars forming compound sections; weight in pounds per foot, including rivets; sectional area in square inches; moment of inertia; moment of resistances, which—it is implied, though not quite so clearly stated as might be wished—is expressed in square inches; safe distributed load for one-foot span; and co-efficient of deflection. In order that the method of calculation may be clearly understood, a page is devoted to the formulas and symbols employed by the compiler; and another page contains diagrams and rules showing the variations of bending moment, shearing stress, and deflection for different modes of loading. Some of the symbols and the manner in which they are employed in the two pages may not be altogether approved by those who believe in the standardisation of

such expressions, but the important fact remains that the demonstration is consistent and lucid as it stands. We are glad to observe that due notice is taken of deflection in the tables. For instance, all loads to the right hand of a zig-zag line are such as will produce greater deflection than the limit permissible in ordinary buildings. This is an extremely useful distinction. In some of the tables there is a dotted zig-zag line indicating excess of shearing stress, as may be expected in short spans with heavy loading. This, also, is a most excellent innovation. The first part of the handbook is concluded by practical notes of girders and sketch suggestions for various details.

In dealing with columns, the compiler recommends the use of a varying factor of safety, and for the calculation of breaking strength gives a formula which is readily recognisable as that of Professor Rankine. The tables which follow include a fair variety of steel column sections, each table being accompanied by explanatory remarks which will be found valuable to architects and builders, though of course they do not tell the experienced engineer anything new. All essential details are contained in the tables, and the value of r^2 is stated for each section. The handbook concludes with a selection of miscellaneous tables, and we can recommend it as a distinct advance on anything of the kind hitherto published.

Pure Water for Ice-making . . .

THE process of evaporating sea-water to be used in the steam boilers of a vessel at sea has been in operation for a long time, in consequence of the necessity for preventing the deposit of salts on the heating surfaces when the pressures to be carried by these surfaces are high. On the Red Sea littoral, Mombasa, and places where pure water for drinking purposes is scarce, this method has been applied to purify the water before drinking. The evaporation of water and its redistillation was always found necessary when it was required pure for chemical purposes, and now the uses to which ice is put necessitate that the water from which it is made should be purified also.

Of course, natural ice, such as that obtained from the deep and little disturbed lakes of Norway, possesses almost all the qualifications necessary for the table; but ice obtained from shallow, unprotected lakes which have strong currents running through them, and in which mud rises from the bottom and remains in suspension, is a commodity of quite another character, and to prevent the user being provided with ice of that nature it is necessary to adopt methods which will prevent water of inferior quality being used for the production of artificial ice. When therefore it is desired to make artificial ice, it must be an advantage to have the simplest and cheapest methods in operation for purifying the water from which it is made.

The simplest method of producing pure water is to evaporate it, and then condense it, but this is rather expensive. In the British Navy it is usual to use a compound evaporator, and in some steamers tricompound evaporators, which result in greater economy. In some places on land the compounding has gone on until a sextuple effect is produced. The average consumption of steam to produce water by the different stages of compounding are shown in the following table :—

Compound	1 lb.	of steam	produces	1½	lbs. water.
Triple	,,	,,	,,	2½	,,
Quadruple	,,	,,	,,	3	,,
Quintuple	,,	,,	,,	3¾	,,
Sextuple	,,	,,	,,	4½	,,

In these higher stages of compounding pressures of steam up to 40 lbs. or so must be used, with an average working boiler an evaporation of 9 lbs. of steam should be obtained per lb. of coal, and when this is the case the quantity of water evaporated per lb. of coal will be 40½ lbs. This is not an excessive price in fuel to pay for pure water.

In towns like London and New York there is a commercial value placed on "ice made from pure distilled water," and users are willing to pay for the superior article. The rough semi-opaque ice often

given is not in so great requisition as clear pool ice. There is also the further advantage that water out of a well sunk in the factory can be used directly after going through the evaporators, and the first cost of water which has to be paid for is saved. As towns' water costs about 6*d.* per 1,000 gallons, the saving of its cost by purifying the water brought from the ice factory's own well will go a long way towards reducing the expense of purification.

Machinery in Government Factories . . .

SOME years ago, Sir Edward Carbutt was instrumental in securing the appointment of Lord Morley's Committee, nominated for the re-organisation of the workshops of the War Department. The late Sir William Anderson was subsequently appointed to be Director-General of Ordnance Factories, and in that important office he effected numerous improvements in the machinery, and checked various wasteful tendencies. For these reforms the country is greatly indebted to the two civilian engineers to whom we refer, for it may well be doubted whether any officials brought up in the enervating atmosphere of a Government department would have retained sufficient energy or have gained the experience requisite to demand and to carry out any effective re-organisation of the kind. Work of a similar nature now awaits some energetic reformer at the Admiralty, for it is a well-known fact that the machinery and plant at our National dockyards are deplorably obsolete. Yet nobody seems to care. Dockyards are great spending establishments which are neither expected to show profits nor to exhibit any remarkable degree of expedition. Lucrative appointments are looked upon as if they merely existed for the purpose of moderating the asperities of life for their fortunate recipients, and it is rarely that they are regarded as offices demanding ceaseless activity and keen appreciation of the changes taking place in the outside world. Consequently, we find that at Portsmouth, Chatham, and elsewhere, our public servants are contented to potter along with machine-tools forty or fifty years old, and with other appliances of the same venerable antiquity. Those who are acquainted with the ways of Government departments know that it is very inadvisable for subordinates to suggest anything in the way of improvement. It is well-known in Government departments that promotion to a nominally better position, but at a lower salary, is generally the reward of originality. Consequently, officials of all grades will not risk anything by departing from the beaten track, and obsolete mechanical appliances continue to adorn our public establishments. The same causes militate against the adoption of really up-to-date machine-tools, but no doubt the notorious parsimony of the Treasury is still more to be blamed. Now that rumours of reform are in the air, we sincerely trust that serious attention may be devoted to the whole question.

Aluminium in the Foundry . . .

HUNDREDS of tons of aluminium are now consumed annually in metallurgy. Steel-makers are well acquainted with the fact that ingots are very apt to turn out spongy at the top; and it has been the practice, when particularly good ingots are required, to cut off and re-melt the faulty portion. By adding a few ounces of aluminium to the ton of molten steel, ingots of uniform solidity may be obtained. In the production of large castings the aluminium is added to the molten metal before pouring, but it is frequently found advantageous to insert small fragments in the mould at places where difficulties may be anticipated. Equally beneficial results may be secured by the addition of a small proportion of the metal to iron or brass, either in the mould or in the ladle. The employment of aluminium in this manner causes the instant liberation of all gases contained in the metal, and prolongs the period of fluidity, thus permitting a longer time for the escape of the gases. In nearly all steel works, and in a large number of foundries, aluminium is extensively used, and we believe that the number of "wasters" is consequently

reduced by more than 80 per cent. Another extremely serviceable manner in which aluminium may be employed is for pattern-making. The heavy brass gates of patterns may advantageously be replaced by aluminium, to which about 5 per cent. of copper and an equal proportion of zinc have been added with the object of increasing rigidity. Patterns of light weight naturally enable savings to be effected in different directions. The work of moulding is facilitated, as the men expend less effort in dealing with dead weight; the patterns can be handled and stored more economically; and freight is considerably reduced, as aluminium is about one-third the weight of iron, and less than one-third that of brass. At a recent meeting of the Franklin Institute it was mentioned that a foundry at Philadelphia had some large iron castings to make for a cable tramway, the pieces being intended to extend the full width of the track, supporting the rails and carrying at the centre the conduit for the cable. Wooden patterns were at first used, but considerable trouble was caused by wear and tear in the sand, as well as by warping and springing out of alignment. Finally patterns were made in aluminium, with the result that all trouble ceased, and most excellent castings were obtained. Large sums are spent on permanent iron patterns in various engineering industries, and the value of the metal is probably small as compared with the cost of preparation. In view of the savings to be effected in the moulding shop, the general substitution of aluminium ought to be worthy of consideration.

Lord Selborne and the Navy . . .

THE newly appointed First Lord of the Admiralty has earned a name for himself for industry and application to the work of office, and high expectations are held in many quarters of the advantages to the Navy which will result from his appointment. With the speed of our cruisers three knots lower than those of small naval powers like China and Chili, with the boiler question still in abeyance, that of armament undecided, and with the engineer complements of the ships hopelessly under strength, there will certainly be plenty of scope for the energies of Lord Selborne. The late First Lord of the Admiralty in his last annual statement told the House of Commons that "delays in delivery of materials, difficulties in securing adequate numbers of workmen . . . had caused the aggregate earnings of contract work to fall short of the estimated amount by about £1,400,000 . . . the armour-plate workers will fall short of the amount anticipated by £420,000," while another statement was that while the shipyards were so fully employed more orders could not be placed. A question as to the accuracy of these statements, addressed to shipbuilders and armour-plate makers, elicited the reply that a number of warships could be laid down as soon as the orders for them were received, and more armour plates than the Admiralty could possibly require could be delivered within the year. But as it stands the new programme is a large one, and with such replies from shipbuilders and armour-plate makers there will be no excuse for Lord Selborne should the 17 battleships, 24 cruisers, the sloops and torpedo craft promised by Mr. Goschen to be under construction not have made substantial progress during the present year.

Coal Consumption and Water-Tube Boilers . . .

ON another item a further step towards its solution has been made. Mr. Wilson, M.P., of Hull, has just completed the trials of the Atlantic liner *Martello*, fitted with a type of water-tube boiler not greatly inferior to that placed in the larger warships of the British Navy. It appears that the fitting of such boilers saved in the first instance 100 tons of weight, and as he had the records of a 7,000-miles cruise of the *Martello* with the old cylindrical boilers, he sent her for another of the same distance with the new ones. This particular result shows an advantage in favour of the water-tube boiler, but it

should be remembered that the working of them is still in the hands of the contractor. The coal consumption records in the Navy are not in favour of the water-tube boiler. As it used to be argued in favour of water-tube boilers that their saving in weight allowed of greater armament being carried, this advantage now passes. Greater armament can certainly be carried with water-tube boilers, but it will be at the expense of bunker capacity and reduced radius of action. Since, therefore, the cruising-power radius of action and the weight-saving is all in favour of the cylindrical boiler, there remains only the tactical advantage standing on the credit side of the water-tube boiler. One is the more impressed with the justice of this conclusion since so eminent an authority as Lord Armstrong elected to fit cylindrical boilers in the *Hai-Chi*, 24 knots, and the *Buenos Aires*, 23·2 knots, the world's fastest cruisers. Even the advocates of the water-tube boiler agree with Lord Armstrong that in cruising power, coal consumption, and ease in stoking, the cylindrical boiler is to be preferred; and the public at least will be impressed with the fact that Lord Armstrong chose to drop the tactical advantage in favour of cruising power and ease in stoking.

Electric Locomotion for Railways . . .

THE electric tramway has come to stay; the electric railway is making its appearance in various parts of the world, and, representing speed in its highest form, is welcomed by an age which sacrifices much to speed, and will not hesitate much longer to sacrifice also the dignified old steam-engine, which has rendered such good service to mankind for many years, that it may be excused for the conceit of believing that nothing can ever fill its place.

Among the pioneers of electric railway locomotion is the *Waunsee-Bahn*, near Berlin, equipped by Messrs. Siemens & Halske, pioneers themselves in electric enterprise. The line has a length of 12 km., and, for the time being, has six trains running on it each day. In the spring of 1902 the building of the electric elevated railway at Berlin is to be opened to traffic, which will require steam-power aggregating 3,000 h.p. to be furnished by three engines. These pioneer lines, no doubt, will soon be followed by others, and there are already many projects under consideration that promise fair success. Our London pioneer enterprise in using electric motive-power on railway-track needs no further comment. Its success appears more than assured. Paris also has followed suit in building its electric underground railway. Though originally perhaps, deserving to be classed among the "exhibits" of the Orleans Railway, it will survive all the other exhibits and, what is better, be—unlike the latter—a paying investment. The motive-power is, as in our own new line, furnished by two electric locomotives with four axles and four motors of 550 volts. The steam-power at the central station at Dory is furnished by two steam-engines direct connected to two three-phase alternators, whose aggregate of 5,500 volts is reduced by transformers to continuous current of 550 volts. There are other lines in existence, in course of construction, and projected in smaller towns; but London, Paris and Berlin lead European progress, and their pioneer enterprise will mark the beginning of the electric railway era in history. The enterprise, it cannot be denied, is *fin de siècle* historically; but let us hope that it is not *fin de siècle* in the Parisian meaning of the phrase.

Comparative Cost of Power Generation . . .

AMONG the many papers of practical value read before the British Association on the occasion of the meeting at Bradford, on September 7th, that contributed on the above subject, although apparently a compilation merely from various technical publications and similar sources, is in reality far more, since the author, instead of mechanically reproducing the items collected, has restated the information contained in them in

a form which renders a comparison very easy, and has thus furnished us with a very welcome set of data that will be of great assistance in all inquiries into the comparative cost of the various modes of power production. He has classified these data under three heads, the first being Steam Power, the second Water Power, and the third Gas Power, and, in the final section, has tabulated the lowest recorded costs of power per e.h.p.-year of 8,760 hours, derived from water, steam, blast-furnace gas and producer gas, in Canada, England, Germany, Switzerland, and the United States. From these tabulated results we see that water power is, as has been generally assumed, the most economical source of energy wherever it is obtainable without excessive expenditure for the hydraulic plant and cost of maintenance, and where the power generated is consumed in proximity to its source, and has not to be transmitted over long distances; otherwise the margin between the cost of water and steam power is very slight, and often disappears entirely. The author merely states this fact, but it would be both interesting and useful to determine, at least approximately, the limits within which this margin is confined. He arrives, however, at the definite and important result that "electrical energy, generated by falling water, is costing more at Rheinfelden, at Zürich, and at Buffalo, than it would cost in South Lancashire, if generated by steam power in large units; and the margin between the actual charge for water power at Niagara, and the estimated cost of steam power in large generating stations in South Lancashire, is only 12*s.* 1*d.* per e.h.p.-year. The fact that steam power, generated in large units in close proximity to the fuel, is one of the most economical sources of electrical energy is fully realised in Germany also, where experience has shown that water power can be profitably used only under strictly determined conditions. Many critics of British methods, who have been in the habit of declaring that, while on the Continent water power is employed on a large scale, in Great Britain it is permitted to run to waste, forget, as Mr. Alexander Siemens pointed out in the discussion on the paper, that where in Germany, Switzerland, and France water power is chosen to supply the power for driving dynamos, this is due to the fact that such water power is constant and inexhaustible, while we do not possess such water powers, and the utilisation of those that we do possess would certainly cause financial loss to the contractor. Commenting on the great strides that are being made in the evolution of gas engines, and in their feeding with blast-furnace gases, the author believes that it is too early to prophesy what place they will occupy in the future industrial development of this and other countries, since it is as yet not known what expenditure will be required for their maintenance and repair within definite periods. This is certainly true, but he adds, that even if the use of blast-furnace gases would reduce the cost of fuel in gas engines to a minimum, blast furnaces demand coke, and coal beds are exhaustible, and if this source of electrical energy should fail it would necessarily result in the triumph of the waterfall and of the turbine. We cannot quite agree with this reasoning, as, after all, the exhaustion of our coalbeds is not likely to occur in the near future, nor is the constancy of some waterfalls an absolute certainty; so that, as far as permanency is concerned, both sources of power are probably equally insecure if we anticipate the distant future, and equally secure if we confine ourselves to the next few centuries. Meanwhile, however, scientific knowledge is progressing, and we may expect, without entering upon groundless speculations, that where one source of power fails another will be discovered. For the time being, at all events, it is wiser to utilise and develop those that are given to us than to anticipate their ultimate exhaustion.

Aerial Navigation . . .

There have been many rumours of a contradictory nature regarding Count Zeppelin's dirigible balloon, among them being the news that the famous balloon

has been bought by the German Government. If so, we must assume that the belief of the authorities in the practical value of the invention is based upon secret information, for in the result of the experiments there is certainly nothing to indicate that Count Zeppelin has been much more successful than the inventors who preceded him. The main problem, of course, to be solved by the constructors of air-ships is to find a method of sailing against the wind, and such a method remains as yet undiscovered. The machines of Giffard and of De Lôme travelled with a velocity of ½ to ⅓ of a metre per second, that of Renard and Krebs made 7 kilometres in 23 minutes—*i.e.*, 5 metres per second, while Count Zeppelin's balloon is reported to have traversed the distance of 15 kilometres in 15 minutes, which represents a velocity of 5½ metres per second. Since, however, even a moderate wind has a much greater velocity, the addition of half a metre to the speed of his most successful predecessors will hardly entitled Count Zeppelin to claim superiority for his invention, so far as the main problem is concerned. There may, of course, be improvements in his balloon worthy of serious consideration; but if so, they were, as above said, kept secret, and all that has been published so far leaves us no choice but to praise the good-will of the inventor instead of the good deed.

A Vain Appeal . . .

THAT the average Russian has an almost superstitious veneration for the ruler of his country is well known, but it appears that some of the Czar's subjects seem to believe him to be the arbiter of peace and war throughout the earth. The Guild of Russian Merchants has of late been sending to the Russian Ministry of Finance one petition after another, signed by the members collectively, praying that the Czar should put an end as soon as possible to the troubles in China, so that commercial traffic through Siberia may be resumed. It is a pity that there is not some ruler powerful enough to grant the prayer of these merchants, for, unless we mistake the signs of the times, Europe will earn but little glory and less profit from her China enterprise; but even the autocrat of "all the Russias" has but a small voice where so many demand the right to talk. Though the merchants engaged in Siberian trade, therefore, will probably have to wait a little longer, it cannot be denied that they have a real grievance, since railway traffic in Siberia is entirely suspended, excepting the transportation of troops and war-material. Yet notwithstanding the fact that the railway authorities have completely handed over for the time being their line and the rolling stock, the latter is said to be greatly deficient. It consists of 276 eight-wheel, 232 six-wheel, and 10 twelve-wheel locomotives. To these must be added 117 eight-wheel locomotives lent for use on the Siberian line during the time of the Chinese complications by the other Russian railways. The Siberian Railway owns, besides, over 6,000 closed carriages, 2,300 open vans, 600 special cars, and 50 cistern cars. This seems quite a respectable array of transport material at first sight. Since, however, it is declared to be deficient, we can only assume that the task for which it is employed must be of more than ordinary magnitude, and all signs point to the fact that the Peace Conference at the Hague was a purely academical discussion, taken nowhere less seriously than in the country where it originated.

Railroad Work and Automotors . . .

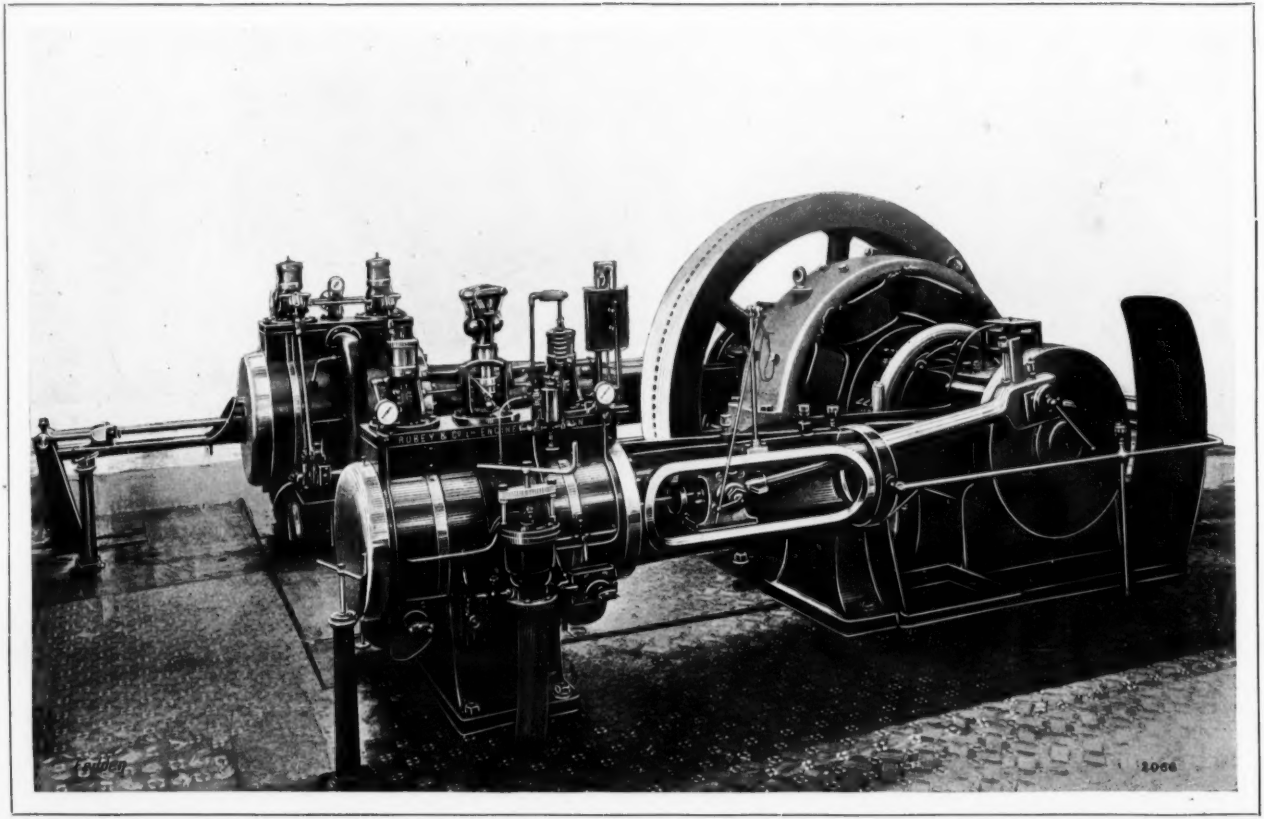
On the occasion of the sixth meeting of the International Railway Congress, held in Paris this year, in connection with the Exhibition, one of the subjects under discussion was the "Use of Mechanical Power." The basis for the discussion was a report drawn up by M. Kerommers, chief engineer of the engine-works at La Chapelle and of Hellemes, M. Lechelle, chief of the motive power department, and M. E. Sartiaux, chief of the electric department, all of them officials of the French Northern

Railway. These gentlemen had asked 227 railway companies for information regarding the use of automotors in their service. To this question 86 companies replied, and from their replies it appears that seven of the great companies use automotors. The Belgian State Railways are experimentally trying, on some of their lines where the traffic is light, five electric automotors. For the Pennsylvania Railway the Baldwin Locomotive Works are building a number of steam automotors. The Mediterranean Railways of Italy use electric automotors. The Nicolas Railway of the Russian State Railway System employs steam-motors. The Imperial Railways of Austria are making experiments on the city railway of Vienna with the "Le Blant" traction-engine. The Société Nationale of the Belgian, so-called Vicinal, Railways, are experimenting with two steam-motors of the Rowan type on the one-metre-track of their city line in Antwerp. The French Northern Railway, finally, is experimenting with both steam and electric motors. From this it will be seen that although the use of automotors in the service of railways is not yet very extensive, at all events a beginning is being made, and there is little doubt that in the near future their number will considerably increase. It has been proved conclusively that on lines with light traffic auto-motors are of the greatest use, and may be employed in the place of light trains whenever the number of passengers is small. Even on lines with heavy traffic, however, such motors will find legitimate employment. Thus, for instance, they may be used on lines running within the area of great towns, where, although the passengers change frequently, the number of persons to be carried by the same train is comparatively small; or they might be attached to trains, in front or behind, for the purpose of collecting and distributing passengers, thus taking the place of so-called collecting trains. No doubt other uses will be discovered in the course of time; but even those above-mentioned seem to promise a constant growth in the auto-motor industry. As regards the motive power to be used in these railway motors, it will be generally agreed that all points toward the use of electricity, stored up in accumulators; for electricity is slowly but surely invading the empire of the railway in more than one direction.

A Trans-Caucasian Pipe Line . . .

AMONG the noteworthy events during the closing year of the century must certainly be mentioned the completion of the main portion of the great pipe line by which Russian petroleum is to be carried in future from the region where it occurs, near Baku, on the Caspian Sea, to Batoum, on the Black Sea. The pipe line has not reached as yet the centre of the oil region, and ends for the moment at Michailowo, on the Trans-Caucasian Railway, so that it has to be transported from the naphtha fields in cistern cars to this station, when it is collected in special reservoirs of a capacity of 30,000 pud (491·4 tons) each. The oil flows from the cistern railway cars through inclined iron pipes running along the track into the collecting reservoirs, and, after having been measured, it is pumped into three receptacles of 120,000 pud (1965·6 tons) each, whence it passes through the pipe line to Batoum, on the Black Sea. Between Michailowo and Batoum there are two other stations, Ssamtredi and Ssupssau, having collecting reservoirs and pumping apparatus. The pressure of the pumps at Michailowo, owing to the natural grading of the line, suffices to make the oil flow to a distance of 117 versts (125 kilometres), while the pumps at Ssamtredi and Ssupssau force it only 47 and 48 versts (50 and 51 kilometres) respectively. The total length of the pipe line up to the port of Batoum is 216 versts (230 kilometres). The pipes, which have a diameter 20 cm. in the open, the walls having a thickness of 8 mm., are sunk into the railway embankment, and provided with valves at intervals of from two to four kilometres, which prevent, in case a pipe bursts, the flowing out of great quantities of the oil. The pipe line has been calculated for a maximum capacity of 60 million pud (982,800 tons) annually.

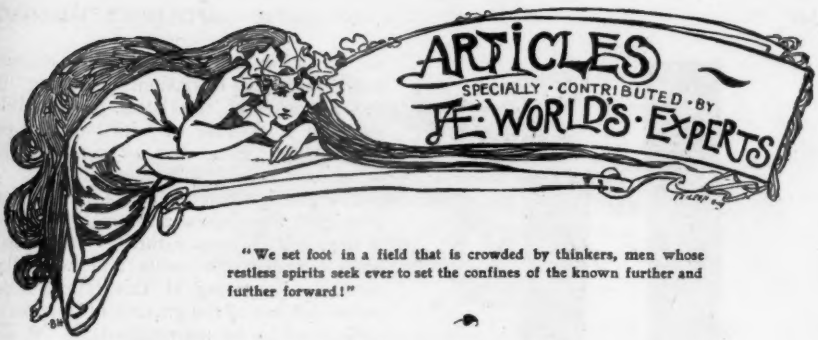
SUP



550 H.P. CROSS-COMPOUND ENGINE BY ROBEY & CO., LTD., LINCOLN, DRIVING A SHUNT WOUND GENERATOR BY ERNEST SCOTT & MOUNTAIN, LTD., NEWCASTLE, AT THE PARIS EXHIBITION.

For description see page 708.

For description see page 708.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

The Generation of Intense Heat through the Combustion of Aluminium

And its Application for Industrial Purposes.

By S. B. ARCHDEACON,

(By special permission of Dr. Hans Goldschmidt.)

THE two elements entering most abundantly into the composition of the earth, viz., aluminium and oxygen, have for many years been known to possess a very strong affinity for each other, and on this fact is based the process for generating intense heat about to be described.

On bringing these two elements under certain conditions together, a chemical reaction is started of so vigorous and energetic a nature that a temperature hitherto obtained only by electrical means is generated with almost instantaneous rapidity. The oxygen necessary for the combustion is obtained from its chemical combinations, principally the metallic oxides, and not from the atmosphere.

Taking ferric oxide as an example, the chemical equation representing the reaction would be:—

$2\,Al + Fe_2O_3 = Al_2O_3 + 2\,Fe$,

metallic iron and alumina being the resultant products.

Some fifty years ago it was known that metallic chlorides, and in a less degree metallic oxides, when mixed with powdered aluminium, set up vigorous chemical action under certain conditions of temperature. But all experimenters—Wöhler, St. Claire Deville, the brothers Tissier, etc.—could only work upon very small quantities and under great practical difficulties in starting the reaction. Their method of procedure being to heat the admixture in a fireclay or graphite crucible, inside an ordinary muffle or other suitable furnace, any close observance or regulation of the reaction was almost impossible, on account of its sudden and vigorous nature.

Under these circumstances a practical

FIG. 1.—TENSILE TEST MADE FROM WELDED TUBE. THE DARK PORTION IN CENTRE SHOWS LINE OF WELD.

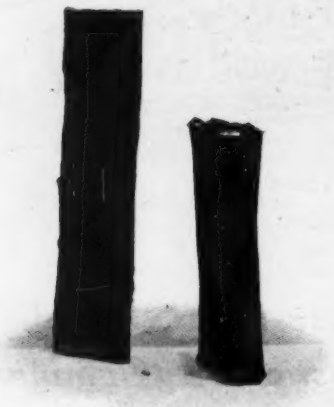


FIG. 2.—WELDED TUBES BURST BY BEING HAMMERED FLAT. THE WELDED PORTION REMAINS INTACT.

application for industrial purposes was out of the question, and it has been left to Dr. Hans Goldschmidt, of Essen-Ruhr, Germany (to whose kindness I am indebted for permission to publish this description), to turn the ideas of a generation ago to practical account.

After some years of costly experimenting, the results of which have been a complete success, a field of application which may be said to be without limit has been opened in most branches of engineering and metallurgy.

In giving some of the details of the most important applications, attention may here be drawn to the most suitable material for lining the crucibles to be used; secondly, to the method of starting the reaction, both being the same in most cases, and for most purposes.

On account of the highly basic nature of the molten alumina, and its consequent corrosive action, when in a molten state, on any refractory material of an acid nature, such as fireclay or the like, a basic lining is absolutely necessary. Magnesia was found to be of great durability; but even more so a lining of the alumina obtained from previous operations, resulting in the adoption of the latter. A crucible so lined is capable of withstanding, on the average, some five or six different operations.

For the ignition of the admixture of powdered aluminium and metallic oxide, a high initial temperature is necessary, and a really practicable and workable method of arriving at this temperature presented one of the greatest of the many difficulties to be surmounted by the inventor. It is a well-known fact that certain superoxides part readily with their extra oxygen at a comparatively low temperature, at the same time generating a very intense heat. After taking advantage of this fact, a method of ignition at once cheap, safe, simple, and certain, was quickly worked out.

By partially covering a small portion of admixed aluminium powder and a metallic oxide, placed at the bottom of the crucible with a little mixed superoxide (preferably barium superoxide) and finely-powdered aluminium, and igniting the latter with an ordinary wax vesta, the combustion is readily and quickly started.

Once thus started, by the simple addition of more material to the white-hot mass, the combustion is prolonged at will of the operator, quick or slow addition allowing of the regulation of the reaction

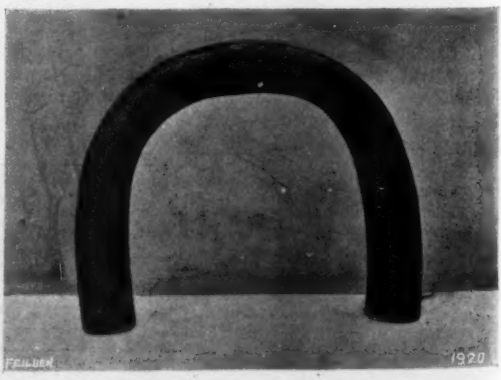


FIG. 3.—WELDED TUBE BENT COLD ABOUT THE WELD.

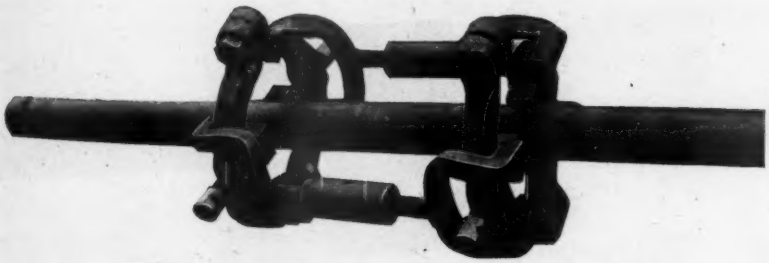


FIG. 4.—CLAMPS USED FOR WELDING TUBES UP TO 4 INS. DIAMETER.

and prevention of too rapid and energetic working. It has been found impossible to measure accurately the temperature generated, but it is estimated to be some 3,000 degs. Cent.

As a result of the simplicity, and on account of the steadily decreasing price of aluminium during the last few years, it is, by a relatively cheap process, possible to apply at a small cost a heat of an intense nature.

At this point may be mentioned, as examples of the many-sided applications of the process, that it is now used—

1.—For the reduction in a state of purity of metals which up to the present time it has been impossible to obtain on a commercial scale, except as ferro-alloys, viz., chromium and manganese.

2.—For the welding together of wrought iron gas and water-pipes, of both large and small dimensions.

3.—For the welding together of rails for ordinary roads, but more especially for electric-tramway purposes.

4.—For the repairing of faulty shaftings, steel-castings, etc.

It is purposed to enter in detail into each of the above-mentioned applications, taking firstly the application of the aluminium as a reducing agent.

For this purpose, on account of the cost, the process can only be applied to metals which have a high value, and are difficult to produce in a pure state by simpler and cheaper means. Chief among these may be mentioned chromium and manganese, both of which, as above stated, have appeared up to the present time on the commercial market in the form of ferro-chromium or ferro-manganese, the former containing from 40 per cent. to 60 per cent. of chromium, and about 18 per cent. of carbon calculated on the weight of this metal, this pointing to the fact that the chromium is present not altogether as metal, but also as carbide, and that the resultant chromium-steel is not in reality an alloy of the two metals iron and chromium, but

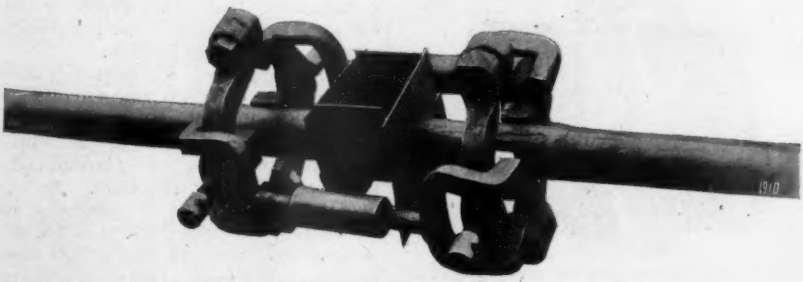


FIG. 5.—TUBES WITH CASTING FORM IN POSITION FOR HORIZONTAL WELDING.

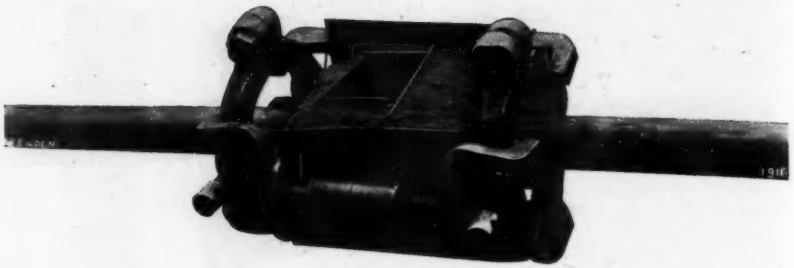


FIG. 6.—TUBES READY FOR WELDING.

rather of chromium, carbon, and iron. The pure chromium as produced by aluminium, being absolutely free from carbon, gives, on addition to steel, an altogether different product to that of the ferro-chromium, the alloy resulting being physically softer and not so brittle.

Ferro-chromium containing so much carbon renders its addition above a certain percentage absolutely impossible for steel purposes, whereas the pure chromium may be admixed with advantage to a much larger extent. By a judicious use of both the pure metal and ferro-chromium, it is possible to manufacture a very much higher percentage chromium-steel than hitherto found practicable.

Since the commencement of smelting operations a few months ago by the Chemische Thermo-Industrie at Essen, Germany, and the Société d'Electro Chimie, at St. Michel de Maurienne, in France, several waggon-loads of chromium for use in the manufacture of hundreds of tons of steel have already been delivered.

The reduction of the metal is exceedingly simple, taking place according to the following equation :—

$$Cr_2O_3 + 2Al = Al_2O_3 + 2Cr.$$

The admixture is ignited as above described, and after the reaction is finished the slag and metal, when cold, are separated easily from each other.

The reduction of manganese is equally simple. So prepared, the metal is principally required for the manufacture of manganese-bronzes free from iron, for special qualities of manganese-steel, and as a deoxidising agent (more especially for nickel-castings) in the place of magnesium or aluminium.

On account of the cost of manufacture, it is not possible to place on the market a manganese that can compete in price for steel-making against the materials at present used for that purpose.

The manganese so prepared alloys readily with copper, tin, zinc, etc., it being found possible to produce manganese-copper containing up to 50 per cent. of the former metal, for use by bronze manufacturers for further admixture. An alloy containing 5 per cent. of manganese and 95 per cent. of copper has been found to possess great strength and a high resistance to change in structure when subjected to high temperatures.

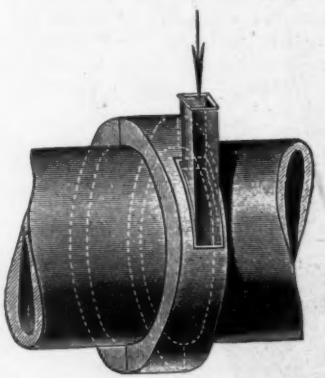


FIG. 7.—SHEET-IRON FORM REQUIRED FOR TUBES OF LARGE DIAMETER.

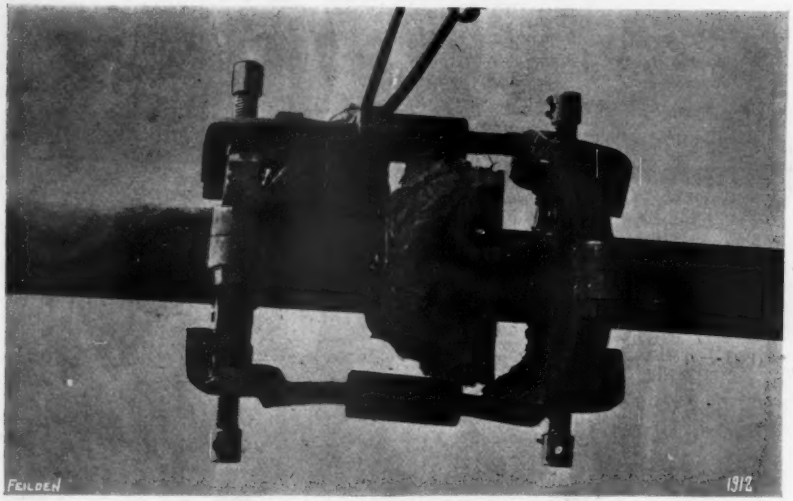


FIG. 8.—SHEET-IRON MOULD ARRANGED FOR VERTICAL OR SLANTING WELD.

Of especial interest to steel manufacturers is the production of ferro-titanium, containing from 10 to 25 per cent. of titanium, and absolutely free from carbon, small additions of this material giving the steel a particularly strong and fine-grained structure.

The slag obtained from the combustion is also not without its value, especially that resulting from the manufacture of chromium, it being to all intents and purposes an artificial emery or corundum. This material, to which has been given the registered name "Corubin," has been proved by a great number of experiments to be harder, and more adapted for grinding and polishing purposes, than natural emery of the best quality.

It is hardly necessary to remark that, on account of its highly refractory nature, it is of great value for furnaces where exceedingly high temperatures have to be withstood.

THE WELDING TOGETHER OF WROUGHT-IRON GAS AND WATER PIPES.

It is evident that a really practical method for welding together wrought-iron

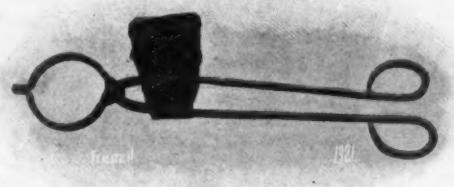


FIG. 9.—CRUCIBLE AND TONGS USED FOR SMALL-SIZED PIPES.

FIG. 10.—TONGS REQUIRED FOR TUBES OF LARGE DIMENSIONS.

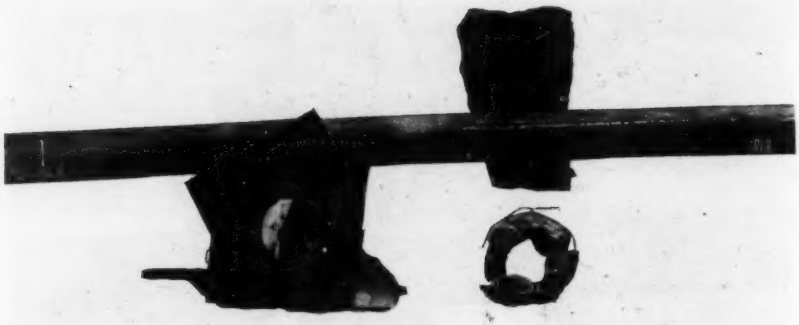


FIG. 11.—TUBES WITH CASTING FORM AND MASS KNOCKED OFF, AND CRUCIBLE USED FOR HEAT REACTION.

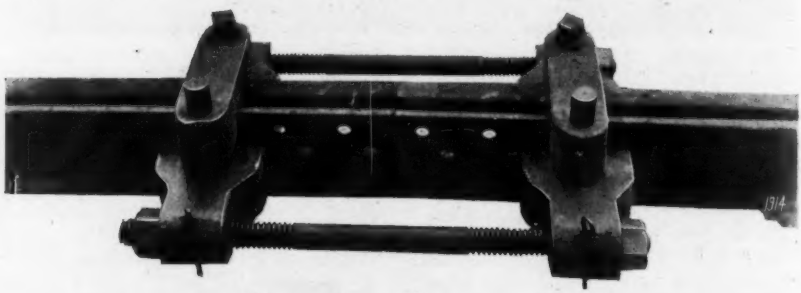


FIG. 12.—RAILS CLAMPED FOR WELDING.

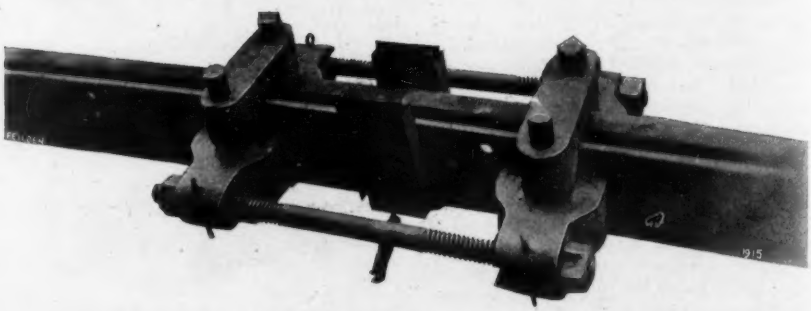


FIG. 13.—RAILS CLAMPED FOR WELDING.

steam and water pipes of both large and small sizes would in a great degree supersede both the flange and socket joints at present in use.

It is doubtful whether the methods now employed for this purpose, viz., heating the pipes with coal, water-gas or electricity, can be considered as satisfactory. The objections raised against these methods are principally the impossibility of welding in all fixed positions, the necessity of relying on the skill and trustworthiness of the workmen employed, and the difficulty of obtaining an absolutely uniform weld.

A precise description of a new method for welding together such pipes—a method free from the above-mentioned disadvantages, and which may be said to work with machine-like precision and regularity—should be of interest to both mechanical and mining engineers, particularly so as skilled labour is not necessary, perfect reliance may be placed on the uniformity and durability of the weld, the use of packing and the risk of leakage are obviated, the cost is less than that of a good flange or socket-joint connection, and no repairs are required.

A further great advantage is, the size of the tube being known, the exact quantity of heating material necessary for the weld may easily be calculated, obviating entirely the danger of over or under-heating, and at the same time all waste.

The process consists in clamping together the two tubes to be welded, and then casting on the joint a molten admixture of slag and metal at a temperature of some 3,000 C., in order to bring the iron up to a welding heat.

The increase of temperature causes the pipes to expand, but they are prevented from doing so longitudinally and outwardly by the clamps. The expansion, therefore, taking place within a restricted area, acts as a welding force upon the tube faces, pressing the hot malleable iron together, being further assisted by

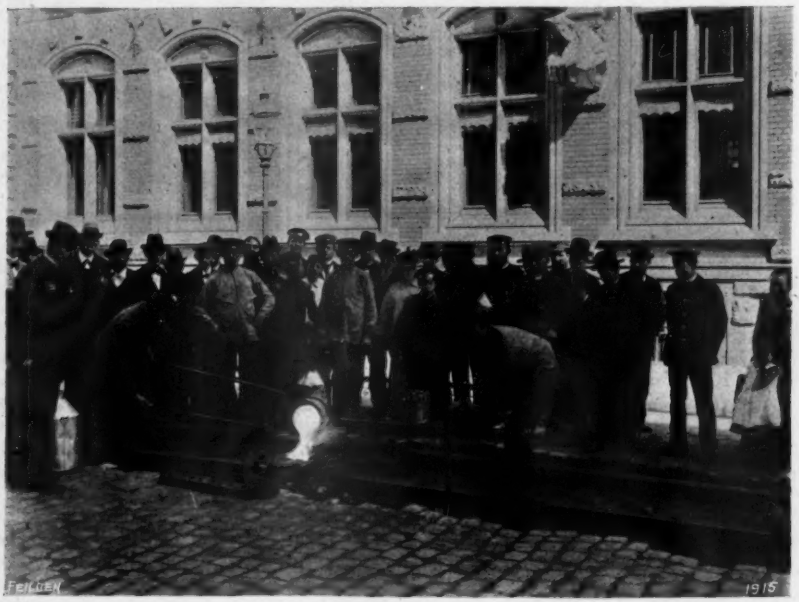


FIG. 14.—RAILWAY WELDING ON AN ELECTRIC TRAMWAY IN BRUNSWICK, MAY, 1900.

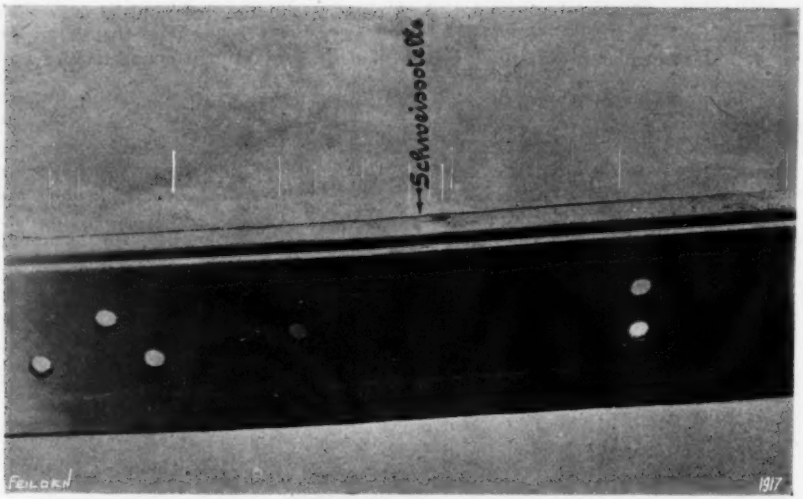


FIG. 15.—RAIL AFTER WELDING.

a screw arrangement on the spanning mechanism.

The heating agent, consisting chiefly of powdered aluminium and oxide of iron, has been patented and registered in all industrial countries under the name Thermit. It is practically smokeless, and emits when burning no noxious fumes, is not subject to spontaneous combustion, but slightly deteriorates in calorific power when exposed to a moist atmosphere.

For the whole operation nothing more is required than a slag-lined, fire-clay crucible, a pair of tongs, a clamp, the necessary Thermit, and a box of matches; the total weight of same being, for pipes up to 4 ins. in diameter, about 50 lbs. (larger pipes requiring slightly heavier implements), a distinct advantage in comparison with the tools required for other processes.

Having given some of the working advantages, a few facts as to the strength of the weld will no doubt be of interest. Repeated experiments and trials have proved that the weld is capable of withstanding a pressure of up to 400 atmospheres, against some 100 atmospheres of an ordinary flange or socket-joint.

Further experiment showed that on hammering, the longitudinal weld split or cracked before the transverse weld gave indication of alteration (see Fig. 2); also, that the pipes could be bent to almost any angle without disturbing the weld connection (see Fig. 3). On drawing in a cold state, the pipes invariably broke at a spot other than the transverse weld (see Fig. 1).

As before mentioned, the cost is less than that of a flanged or good socket joint (especially so where a high pressure has to be withstood), a 2½-in. pipe costing from 2*s.* 6*d.* to 3*s.*, profit included, against about 5*s.* for a goods flange. This sum, which includes crucible, mould, and labour, is considerably reduced should a large number of welds be undertaken at one time.

Against these advantages, the only disadvantage that can be brought against the new process is the difficulty of disconnection, should such be found necessary.

It is, however, understood that for temporary purposes no weld would be made, and as in most cases steam and water pipes may be regarded as permanent fixtures, this drawback is more imaginary than real. It is also a very simple matter

to saw the pipe and weld in a good tee-piece where a connection is found necessary for any alteration, a proceeding taking very little more time than the removal of a rusty flange.

The expansion and contraction of the pipes are corrected by taking the usual precautions at certain intervals, and inserting compensation joints.

Described in detail, the pipes to be welded, after filing the faces to remove dirt or rust, are pressed together by means of clamps (Fig. 4). In the case of a horizontal weld, a mould of sheet iron (Fig. 5), the size of which depends upon the diameter and thickness of the tube, is fixed underneath and around the adjacent faces, acting as a receptacle for the molten Thermit; it is surrounded on the outside with founders' sand to prevent accident and leakage of the molten material (Fig. 6).

The admixture of aluminium and ferric-oxide, which, as before stated, has been patented under the name Thermit, is then ignited, as previously explained, a crucible of a capacity corresponding to the size of the pipes being used.

The white-hot fluid is then cast rapidly into the sheet-iron mould until the joint is surrounded at every point by the molten mass.

Immediately on the solidification of the surface, which takes place almost immediately, a little sand is added to prevent unnecessary loss of heat.

The requisite welding heat is imparted to the tubes within 1½ minute after casting, in the case of pipes of about 2·5 in. diameter and ⅛ in. in thickness, whereas for smaller and larger sizes less or more time is required.

At the expiration of the necessary interval, the clamps are shortened by about one-twelfth of an inch in order to assist the natural force exerted by the expansion in a confined area, after which the weld is complete.

The tubes are then allowed to cool, the clamps removed, and the solidified slag and regulus are detached by a slight blow with a hammer.

In the case of a vertical or slanting weld the sheet-iron mould is arranged as shown in Fig. 8.

Fig. 9 shows the class of crucible and tongs used for small-sized pipes, and Fig. 7 and 10 respectively the tongs and sheet-iron form required for tubes of large dimensions.

The idea would evidently occur to many that on casting the contents of the crucible upon the tubes, the molten iron would immediately attach itself to same on account of its high temperature. That this however is not the case will be readily understood from the following explanation.

In the crucible are two separate and distinct fluids, below the molten regulus and above the alumina or slag. On

FIG. 16.—REPAIRING A DEFECTIVE STEEL CASTING, SHOWING PIECE CAST ON.

emptying the crucible, the molten alumina is cast first on to the joint, and as it solidifies to a slight extent immediately on coming into contact with the cold iron, a refractory layer or lining is formed which effectively resists the heat of the molten regulus, and prevents it attaching itself to the pipes. In like manner a refractory layer of molten alumina is formed upon the sheet-iron mould, preserving the same from being quickly destroyed, so that it may be used many times over.

Fig. 11 shows a welded tube, together with the crucible, sheet-iron mould, slag, and regulus after the operation is finished. Particular attention may here be drawn to the important fact that the weld so obtained is perfectly clean and complete, no afterwork being necessary. The process is also applicable for welding cast-steel tubes.

As the drawings fully explain the construction of the clamp and sheet-iron moulds, a written description of the same is hardly necessary.

From the following table, which also explains itself, full particulars may be obtained of the various moulds, the crucibles, and the quantity of Thermit necessary for different sized pipes up to a diameter of 6 ins.

THE WELDING OF RAILS FOR ELECTRIC TRAMWAYS OR OTHER PURPOSES.

The method of procedure adopted for the welding of rails is similar in most

Diameter of pipe in inches	Thickness of iron in millimeters	For horizontal weld "b" width of mould. Fig. 7. For Vertical "h" depth of mould. Fig. 8.	For horizontal weld. Length "L" of plate "a"	For Vertical weld. Length "L" of circular bent sheet iron mould. see Col. 3 Fig. 8. Section.	Space "a" necessary between pipe and mould. Between pipe & bottom of mould in case of horizontal weld only ¾" a" to be allowed. For Vertical weld bottom of mould to be placed below adjacent faces. slightly less than half total depth.	"Thermit" in Kilogrammes	Clamps to be tightened in ½ minutes after application of molten "Thermit"	Size of crucible
		Measurements in millimeters.						
		h_1 and h_2	L	L_1	a		n =	
½	2,5—3	50	157	86	14	0,28	1	3
	3,5—4,5	50		102	16	0,45	1	
	5 —6	50		118	19	0,60	1	
1	2,5—3	60	219	116	16	0,70	1	
	3,5—4,5	60		126	18	0,85	1	
	5 —6	60		137	22	1,00	1 ½	
1 ½	2,5—3	70	345	130	16	1,00	1	
	3,5—4,5	70		149	18	1,20	1 ½	
	5 —6	70		168	22	1,40	1 ½	
2	2,5—3	80	399	161	17	1,30	1	
	3,5—4,5	80		170	19	1,60	1 ½	
	5 —6	80		190	28	1,90	2	
2 ½	3 —4,5	80	345	156	20	2,40	1 ½	4
	5 —6	80		216	24	2,90	2	
3	3 —4,5	80	408	221	22	3,30	1 ½	
	5 —6	80		245	26	3,80	2	
3 ½	3 —4,5	80	471	250	25	4,00	2	
	5 —6	80		279	32	4,60	2 ½	
4	3 —4,5	80	540	281	29	4,80	2	5
	5 —6	80		296	36	4,80	3	
4 ½	3 —4,5	90	590	306	30	4,40	2	
	5 —6	90		340	38	5,30	3	
5	3 —4,5	100	644	330	30	5,00	2	
	5 —6	100		362	40	6,00	3	
5 ½	3 —4,5	100	694	351	32	6,00	2	
	5 —6	100		382	43	6,80	3	6
6	3 —4,5	100	750	381	35	7,00	2	
	5 —6	100		425	45	8,00	3	

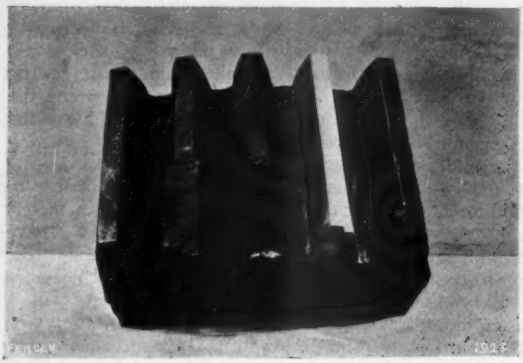


FIG. 17.—COG-WHEEL WITH BROKEN TEETH, SHOWING MACHINED AND UNMACHINED CAST-ON NEW PORTIONS.

respects to that employed for the welding of tubes, above described, the implements employed being, however, much heavier, and the amount of Thermit used for individual welds much larger.

The weld as a substitute for the usual fish-plate has been proved, by practical trials on experimental roads several kilometres in length, between Essen-Ruhr and Steele, and later between the former town and Caternberg, to be uniformly strong and reliable.

As the cost of such a weld is not more, or so much as that of a good fish-plate lashing and copper current connection, and requires no periodical tightening or repairs, electrical engineers in several of the large cities of the Continent, Berlin, Dresden, Hamburg, Braunschweig, etc., seeing at once the advantages of so good a connection, have given orders for many miles of new roads to be welded by means of Thermit.

As a further result of the almost perfect connection obtained, the return current is conducted with very much less loss than formerly. This is a great gain to gas and water companies, it having been proved that the leakage of the return current, as a result of bad connections, is responsible for the, in latter years, relatively short life of the pipes laid by the above-mentioned corporations.

Changes of temperature, as is only to be expected when taking into consideration the fact that the rails are firmly embedded in the roadway, do not affect in any way the strength of the weld or the state of the road. The experimental roads mentioned above have withstood a very hot summer and fairly cold winter without suffering even slight damage or alteration.

Figs. 12, 13, 14, show respectively the rails clamped for welding; the position of the sheet-iron form containing the molten Thermit; and the application on an ordinary tram-road at moment of casting.

Fig. 15 gives a rail after welding, absolutely no after-work having been required.

The application of the process for repairing faulty steel castings is of particular importance, as many castings that would formerly have been discarded on account of their faulty nature, can, at a very slight expense, be rendered sound and serviceable.

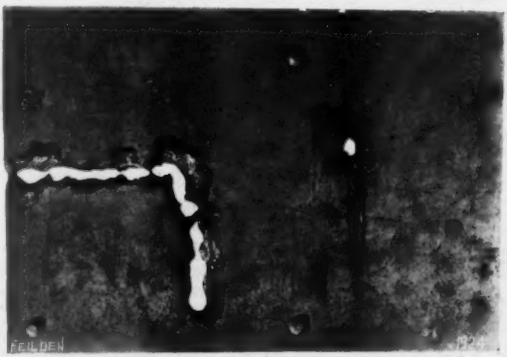


FIG. 18.—NICKEL-STEEL PLATE WHICH HAS BEEN PERFORATED BY MOLTEN THERMIT.

It being possible to produce by the process an iron or steel of any composition that may be required, the repaired spot on the casting can be made, if necessary, of a structure and quality corresponding to the whole.

The method of procedure is again similar to that before described: a small sheet-iron form surrounded by founders' sand being arranged, as the conditions allow, to hold the molten regulus.

After first pouring away the molten slag, the regulus is rapidly cast on to the fault, and the whole is gradually allowed to cool before removal of the mould. For complicated repairs it is better to take, in place of the sheet-iron mould, a properly prepared and adjusted form of clay or other suitable material, in order to secure perfect immunity from leakage.

Should a repaired casting have to withstand any great working strain, it is of great advantage before casting to warm the same at and around the fault, by means of an ordinary coke or charcoal fire. The molten iron, on coming into contact with the hot steel, does not chill so rapidly, the result being a firmer and more reliable weld. In all such repairs a certain amount of afterwork is necessary, such as planing, etc.

Fig. 16 shows a large cast steel pan, on to the faulty rim of which a casting has been made. After planing and removal of the excess of iron, the pan, before unsaleable, was readily disposed of by the founders.

Fig. 17 gives five teeth of a large cogwheel, some 15 ins. in width, and some 3 to 4 ft. in diameter, the centre three of which have broken. The centre tooth shows plainly the nature of the break, that to its left to the rough repair casting of the new process, that to its right the casting after planing. Compared with the value of such a wheel, the cost of repairing is a mere trifle.

It has further been found possible to repair the axles (some 20 ins. in diameter) of large rolling mills, which may have given on account of a faulty casting or the strain to which they had been subjected.

After warming and surrounding with a suitable mould, a certain amount of molten iron produced from Thermit is cast, and this is immediately followed by a further amount of steel from a Bessemer converter. If care is taken in shaping the mould, very little afterwork is necessary.

The Thermit may also be used for softening armour-plates at any point it may be necessary to drill the same. The Thermit on application does not impart a high temperature to the plate other than to the spot to which it has been directly applied.

Further particulars may be obtained from the proprietors of the patents, Messrs. the Chemische Thermo-Industrie, Ltd., Essen-Ruhr, Germany.

Fig. 18 shows a nickel-steel plate, as used for the construction of large safes, &c., and about $1\frac{1}{4}$ in. in thickness, which, whilst in a vertical position, has, with readiness and in an exceedingly short space of time, been perforated by means of molten Thermit.

A. B. Archdeacon

The American Isthmian Canal.

By JOHN GEO. LEIGH.

MR. JOHN GEORGE LEIGH is a Canadian by birth, and has many associations with the United States. He completed his scholastic education at Heidelburg University, where, under Professors Treitschke, Bunsen and Kirchhoff, history and physical science were his special studies.

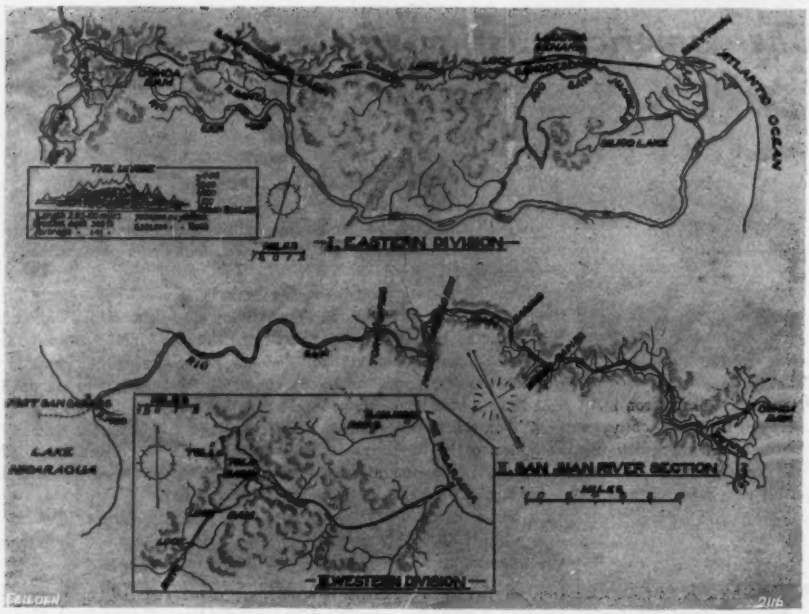
He has for twenty years been connected with the Press, concerning the duties and responsibilities of which he entertains strong opinions. He has acted as Editor of several important provincial journals and Special Correspondent abroad of leading London dailies, and is a frequent contributor on subjects to which he has given particular attention to many prominent periodicals—technical and general—of England and America.

He is specially conversant with international politics and commercial questions, and with matters connected with the promotion of British interests in the Pacific Ocean. He has closely followed the question discussed in the following article, and, in order to speak with authority on all its phases, has devoted mcuh study to the technology of the subject.

THERE is, or should be, no question of greater interest to the civilised world, irrespective of nationality or creed, than the problem discussed in the present article. Yet it is safe to say that no subject of equal importance could be mentioned regarding which there prevails a larger measure of notorious and widespread misunderstanding. This is the more remarkable seeing that the question is not of mushroom growth, but has been under discussion, sometimes with great passion and apparent fulness, during three and a half centuries.

Under ordinary circumstances it should be quite unnecessary to offer arguments in support of the proposition that an early solution of the problem is no less feasible than essential to the progress of humanity. Of late years, however, so many side issues have been raised, so many appeals made to international and political prejudice, so many unworthy considerations dragged into the debate, that the public, and men of science even, find it no easy task to determine where falsehood and imagination end and truth and reality exist. To rescue the question from this unhappy condition, bring home to the minds of his countrymen the dangers lurking in continued neglect of British interests, and provide a suitable foundation on which it may be possible to fairly discuss the matter in relation to both economic and engineering principles—these will be the main purposes of the present article. History will be found to supply the most valuable and trustworthy data for such an enterprise, and the author consequently offers but scant and half-hearted apology for the absence in the following pages of technical detail. He may, however, claim for one of his objects that it finds suitable expression in a magazine "militantly British"—recognisant of the changes which have created a new world since our forefathers laid the foundations of our greatness; conscious that even now we stand on the threshold of a new era of commercial development, and prepared to testify that it is neither dignified nor worthy of our reputation to boast of prestige without making adequate assurance for its defence.

In England, it is necessary to face and overcome the following, among other, misconceptions:—



ROUTE OF THE PROPOSED NICARAGUA CANAL.

1. That no combination of events can rob us of that proportion of the world's carrying trade which we at present possess;

2. That the safety of the Suez Canal satisfies our most pressing and, consequently, all important commercial necessities in regard to navigation;

3. That however desirable may be a maritime canal through the Central American Isthmus, the United States would be the greatest gainers thereby and its value to British commerce would be comparatively small;

4. That to-day there is only one feasible project before the world for uniting the waters of the Atlantic and Pacific Oceans, viz., the Nicaragua Canal, constructed and controlled by the United States; and

5. That we might fearlessly depend upon such an enterprise to minister to all our requirements on an equal footing with other nations.

For present purposes, it will be found convenient to discuss under a single head the three first propositions, and to depend upon the historical survey of the question to disclose the author's views regarding the remainder.

Concerning the probable effect upon existing trade routes of a maritime canal through Central America, study of the following table of distances will repay perusal. It should be mentioned that the figures relate particularly to the Panama project, and that for certain ports each of the proposed routes is a little shorter than the other. Though Greytown and Colon (Aspinwall), the Atlantic termini of the Nicaragua and Panama Canals respectively, are about 300 miles apart, the sailing distances from New York are practically the same; and for traffic in the aggregate it matters very little whether we consider figures relating to one scheme or the other.

COMPARATIVE TABLE OF APPROXIMATE DISTANCES

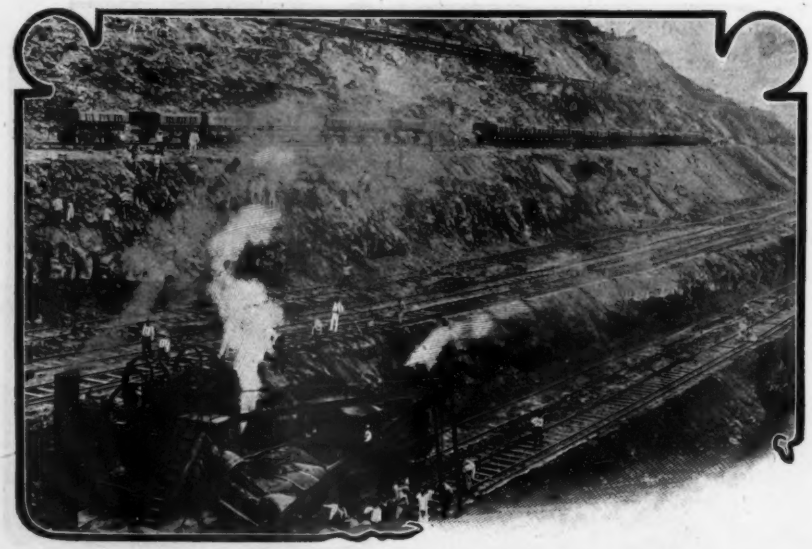
(Nautical Miles.)

	By Cape Horn.	Cape Town.	Suez Canal.	Panama Canal.
Plymouth to Vancouver ...	14,200	.....	.....	8,500
,, San Francisco ...	13,500	.. ...	.....	7,800
,, Honolulu	13,700	.....	.....	9,200
,, Valparaiso ...	8,700	.....	.....	7,000
,, Callao	9,950	.....	.....	5,850
,, Yokohama ...	.....	... ..	11,350	10,600
,, Hongkong ...	.....	.....	9,900	13,600*
,, Wellington ...	11,900	13,000	.....	11,600
,, Sydney	13,000	12,600	11,800	12,500
New York to Panama	11,050	.....	.....	1,925
,, Guayaquil ...	10,450	.....	.....	2,770
,, Callao	9,800	.....	.....	3,265
,, Valparaiso ...	8,450	.....	.....	4,530
,, San Francisco ...	13,300	.....	.....	5,200
,, Manila	17,000	.....	11,700†	11,000
,, Yokohama ...	.....	.....	.....	8,400
,, Sydney	.....	.....	.....	10,250
,, Wellington ...	.....	.....	.....	9,400

England to Vancouver, viâ Quebec and Canadian Pacific Railroad, 5,680 miles; thence to Yokohama, 4,300; to Auckland, 6,100; and to Sydney, 6,900.

England to San Francisco, viâ New York and Southern Pacific R.R., 6,500 miles; thence to Auckland, 5,900.

* Viâ Manila. † Viâ Hongkong.



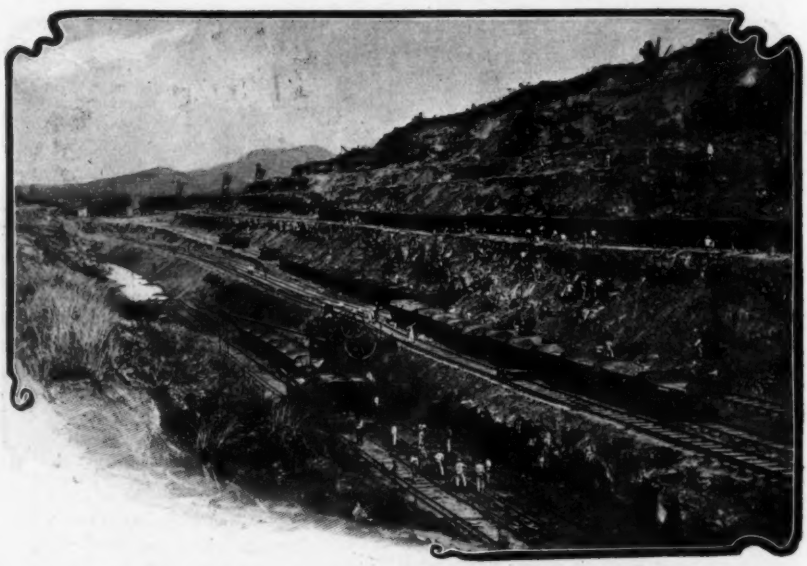
AT WORK IN THE CULEBRA CUTTING: SHOWING THE WORKINGS AT DIFFERENT LEVELS ON THE LEFT SLOPE OF THE CERRO CULEBRA.

Original height above sea on axis of canal (kilometre post: 54·540) ... 324 ft.
Actual height, bottom of cunette ... ... 190 ft.

Depth of excavation ... ... 134 ft.

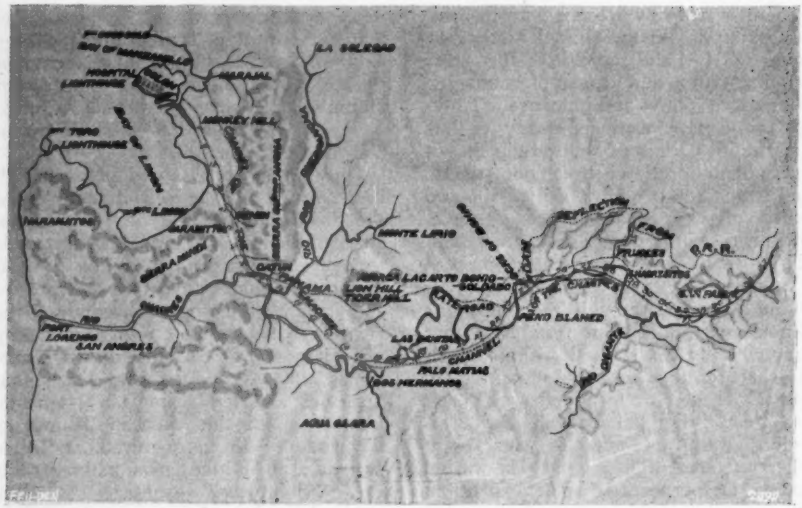
The United States, and especially the great cities of the Atlantic coast, are obviously destined to be very considerable gainers by the opening of an inter-oceanic canal. The latter must materially strengthen the Republic, not only in a political sense, but also by improving her already unrivalled situation with regard to the markets of the world. It will bring into closer touch her Atlantic and Pacific seaboards, place New York, Philadelphia and Boston in rapid communication with the western littoral of South America, and materially assist the Union in the coming strife for the commercial supremacy of the Pacific. No surprise should be occasioned if, under future conditions, a large amount of the carrying trade we now possess falls into American hands. Of the total commerce of Japan, the United States already claims 21 per cent.; of that of China, 7 per cent.; of that of British Australasia, 6 per cent.; and of that of all Asia and Oceania, 7 per cent., imports largely predominating in every case; and the increase shown by these percentages in the future will depend not so much on the amount of energy exhibited by the Americans as on that shown by ourselves. In this connection it should not be forgotten that the projected canal will not only bring nearer to us by many thousands of miles the markets on the Pacific from Valparaiso to Vancouver, but also provide routes, alternative and possibly, under certain conditions, of equal value to the Suez Canal, to the Far East and Australasia.

Of the vital importance to the New World of the piercing of the isthmus, no better proof can be submitted than the following extract from a report presented to the United States Senate in June, 1896, by a Select Committee, to which had been referred a Bill for the construction of a waterway through Nicaragua "as an American canal under American control":



VIEW TAKEN FROM A POINT 72 METRES ABOVE SEA, LOOKING TOWARDS COLON.

Original height above sea on axis of canal (P.K. 54·450)	332 ft.
Actual height, bottom of cunette	183½ ft.
Depth of excavation	148½ ft.

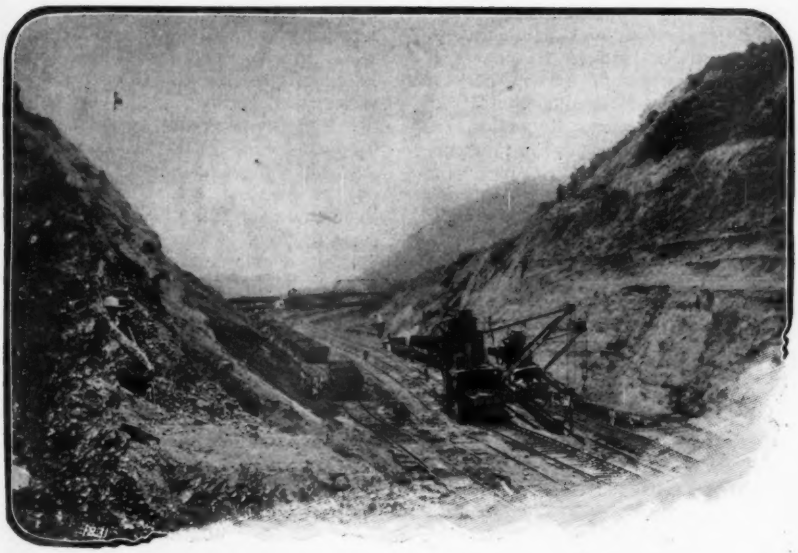

LA SOLEDAD
HOSPITAL
LIGHTHOUSE
MIRAFLORES
MONKEY HILL
PT. TIGRE
LIGHTHOUSE
MARAVILLES
MARAVILLES
CREEK
WHITE LEVIS
CULEBRA
CUT
EXCAVATION
FROM
CULEBRA
P.R.R.
CULEBRA
PANAMA
CULEBRA
CUT
CULEBRA
CUT
CULEBRA
CUT

"There is not any interest in any business enterprise in the United States that would not feel the impulse of this great movement in a new career of commerce and national power and influence. To do this work in a manner worthy of our opportunities, we must shorten the line of water communication between our Atlantic and Pacific States. If we fail in this, we shall soon occupy a position, as a people, inferior to our kindred in Europe, and will be left to inherit only the reproaches of posterity. . . . It is the combination of these powers, through the Nicaragua Canal, that alone can establish that national unity and strength without which the chain of the Rocky Mountains may one day become the boundary between two great rival republics." These observations warn us, and to this point fuller reference will presently be made, that if, for purposes of trade expansion, offence and defence, an isthmian canal is of prime value to the United States, it is of no less importance to the rest of the world, and peculiarly to Great Britain, that such a work of civilisation should be, and ever remain, in the fullest sense of the term, "an open door," constructed and maintained "for the benefit of mankind, on equal terms to all." (Clayton-Bulwer Treaty, Art. 6).

Only seven years elapsed between Balboa's march to Panama and discovery of the "Great South Sea" and the formulation of the first of many serious proposals to realise Columbus's dream of an alternative and abbreviative Western route to Far Cathay. To Angel Saavedra and the year 1520 belong the credit of initiating an agitation which, to the world's shame be it said, has endured for nearly four centuries. A few years later Hernando Cortes caused the Mexican isthmus of Tehuantepec to be surveyed, and then submitted to his king a memorial regarding the possibility and advantages of a navigable channel to unite the Atlantic and Pacific Oceans; and there is little doubt that action would have followed but for

VIEW TAKEN FROM A POINT 70 METRES ABOVE SEA, LOOKING TOWARDS PANAMA.

Original height above sea on axis of canal (P.K. 54·450) ... ... 332 ft.
Actual height, bottom of cunette ... ... 183½ ft.
Depth of excavation ... ... 149½ ft.



EXCAVATORS AT WORK: VIEW, LOOKING TOWARDS PANAMA, TAKEN FROM WORKINGS 67·50 M. ABOVE SEA.

Original height above sea on axis of canal (P.K. 55·000)	311 ft.
Actual height, bottom of cunette	167 ft.
Depth of excavation	144 ft.

the malign interposition of Holy Church. In those days, however, enthusiasts were neither few nor far between, and to the Portuguese Galvao in 1550 is due the introduction of the Lake of Nicaragua as one of the routes most strongly advocated. Unfortunately for any enterprise of the kind, England and Spain now entered on their long struggle for the mastery of the isthmus, and thenceforward, thanks to the rivalries of these and other nations, the question slumbered for nearly three hundred years. The illusory promise of international peace offered in 1814 revived Spain's interest in the matter, and the Cortes went so far as to order the isthmus of Tehuantepec to be pierced. Little or no progress, however, was made with the work, and the next endeavours to secure a solution of the problem came from the recently-revolted Central American Republics. These communities were quick to recognise the world-wide importance of an isthmian water-way, and its peculiar importance to themselves and the United States; and many were the negotiations opened and concluded with a view to the construction of a canal by American enterprise and capital. For the non-fruition of any one of these schemes, two reasons must be assigned—first, British opposition, culminating in the Clayton-Bulwer Treaty of 1850; and, secondly, American fears lest the matter might involve an "entangling alliance" foreign to the traditions of the Union.

In 1846, however, the United States acquired from the Republic of New Grenada, now Colombia, certain rights of transit at Panama, and two years later concluded with the same Government a convention interesting as the original authority for the construction of the Panama railroad. This document is noteworthy to-day in view of the fact that it guaranteed equal rights to the citizens of all nations, not only in connection with the projected railroad, but also all means

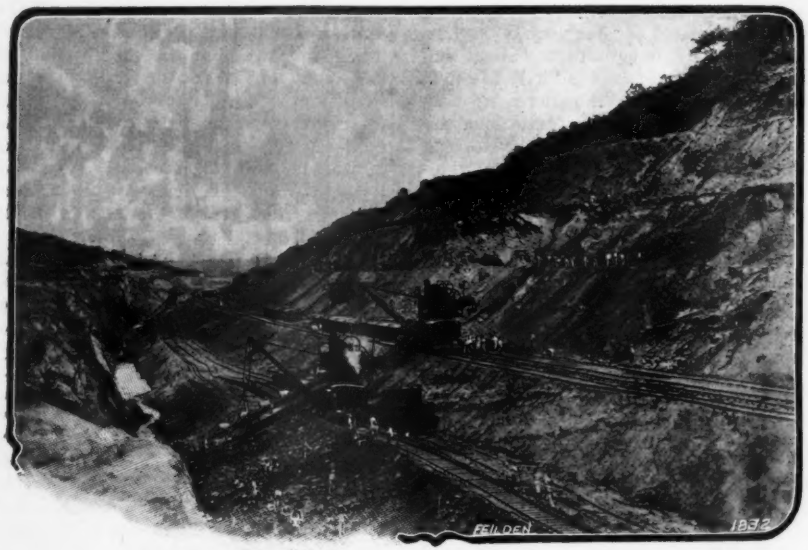
of interoceanic communication which might be opened across Colombian territory. A similar provision appears in practically every treaty concluded between Great Britain or the United States with other Central American Republics. At this time, as one result of the acquisition of California, American interest in the Canal question was more than usually lively. During a mission of inquiry to Nicaragua, Mr. Hise, the U.S. Chargé-d'Affaires in Central America, concluded, without authority from Washington, a convention securing to his country the exclusive right to construct a canal through Nicaraguan territory; and it was on the strength of this transaction that Commodore Vanderbilt organised the Atlantic and Pacific Ship Canal Company, and obtained a concession, soon afterwards cancelled, to execute the work. At this period, owing to a variety of causes, Anglo-American relations were somewhat strained, and it was in the hope of reconciling the conflicting claims of the two nations on the basis of a joint guarantee of the neutrality of the much-debated Canal that the Clayton-Bulwer Treaty was negotiated and signed. On some questions other than the Canal, the Treaty was admittedly faulty, but in 1860, after prolonged effort on the part of diplomatists, the then President was able to announce that the "discordant constructions" of the compact had "resulted in a final settlement entirely satisfactory" to his Government. "From that day to this," as was admitted by the Foreign Relations Committee of the Senate as recently as March last, "no Congress has disputed the finality and validity of this settlement." Yet Great Britain has agreed, by the Convention of February 5, 1900, that the restriction as to the exclusive control of the Canal imposed by the Clayton-Bulwer compact shall continue to bind her, while the United States is released from it.

It is true that many attempts have been made, in furtherance of the idea that the American Government should construct and exclusively control the Canal, to secure the abrogation of the Clayton-Bulwer Treaty. President Arthur was especially anxious to bring about this result, and gave active support to the movement which ended, in December, 1884, in the signature of the abortive Freylinghuysen-Zavala Convention, providing that a canal should be built by the United States, and owned by it and the Republic of Nicaragua. In the following year Mr. Cleveland was installed, and one of his first acts was to withdraw this convention from the Senate, and thus clear the way for the incorporation and eventual recognition by the federal authorities of the Maritime Ship Company of Nicaragua. This company was the outcome of the Nicaraguan Canal Association, which in 1887 entered into a contract with the Government of Nicaragua for the exclusive right of excavating and controlling a canal to be constructed across the territory of the Republic. Mr. Aniceto G. Menocal, a civil engineer in the United States Navy, took charge of a survey expedition organised by the company, and the latter, on his recommendation, resolved that the Canal should follow almost the identical route surveyed early in the 'seventies by Colonel Childs and Commander Lull. Much uncertainty has always prevailed regarding the work actually accomplished by this company. The author has before him various reports presented to the Secretary of the Interior every December, in accordance with the Act of incorporation, in which glowing statements appear concerning large amounts of money expended for labour and materials, the great progress made in the work of construction, and the generally satisfactory condition of the enterprise. These, however, are terribly discounted by the following facts: The formal recognition by the United States Legislature that the company was obviously unable to accomplish its purpose, and the refusal of the Government of Nicaragua to renew the concession of 1887 (which legally terminated on October 9, 1899), "owing to lack of fulfilment of its most essential clauses and the abandonment of the work for nine consecutive years."

Within recent years many Bills, all uniting in the pious opinion that the construction of a Nicaragua Canal should be seriously commenced and pushed to

a conclusion, have been discussed and passed by both Houses of Congress. The latest measures merit particular attention, for upon them and the persistent newspaper headline, "The Nicaragua Canal," the majority of English readers pin their amiable but misguided faith that the American project not only holds the field, but is rapidly advancing towards triumphant completion.

In 1895, in view of the already notorious condition of the Maritime Canal Company, a Government Commission was appointed, with Lieut.-Colonel Ludlow at its head, to make a "preliminary survey" of the proposed route. The members of this Commission approved of the general plan of the company, subject to certain modifications, but recommended that further and more detailed surveys were desirable, and that fuller data should be secured respecting the flow of the river San Juan, the variations of the summit level of Lake Nicaragua, and the average rainfall of the country. Congress accordingly authorised the President to nominate another Commission, appropriated for the expenses of the latter $1,000,000, and directed that all available information should be collected to enable the Commission to arrive at correct conclusions as to the feasibility, early completion, and cost of the enterprise. The President in due course nominated as Commissioners Rear-Admiral Walker, Colonel Hains, of the Corps of Engineers, Mr. Lewis M. Haupt, a civil engineer, ex-Senator Pasco, and five other gentlemen; and the first result of their labours appeared in January, 1899, in the form of a preliminary report transmitted to the Senate. In this document, dated December 26, 1898, and signed by the three first-named Commissioners, it is stated that the latter "visited Nicaragua, personally examined the entire canal region from ocean to ocean, and employed some seventy engineers, with their labourers and helpers for ten months in making



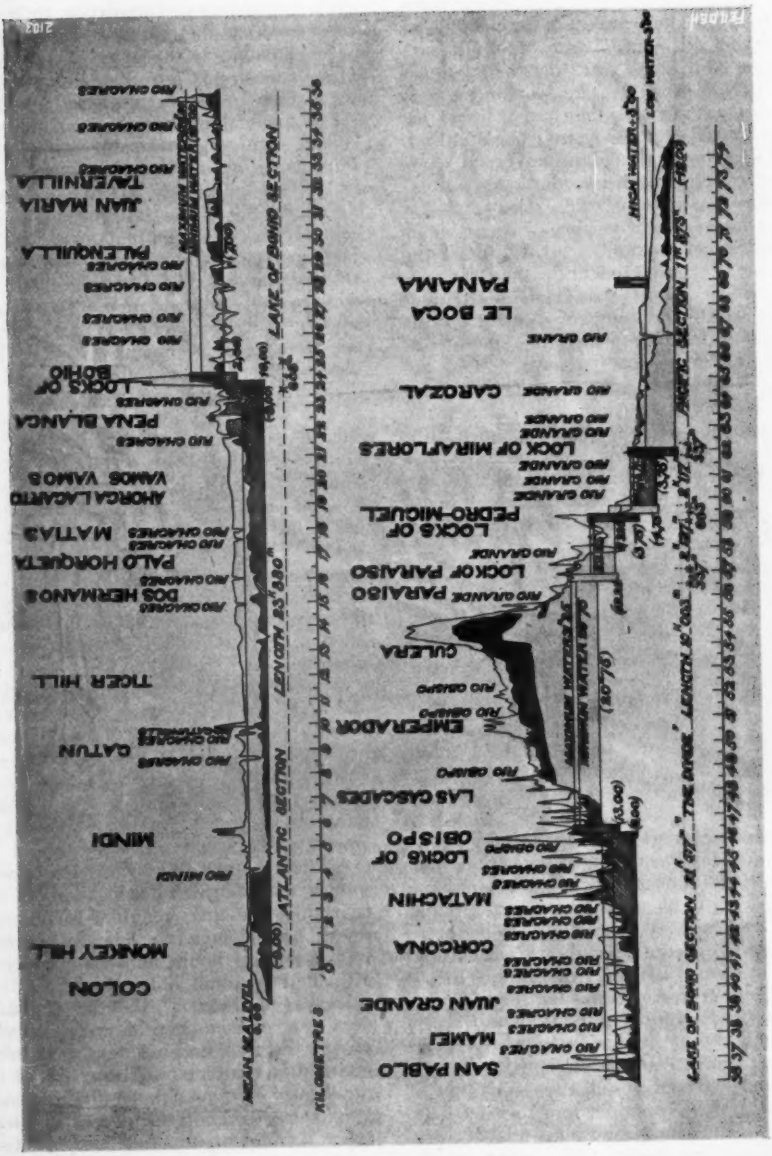
VIEW TAKEN FROM A POINT 75 METRES ABOVE SEA, LOOKING TOWARDS COLON.

Original height above sea on axis of canal (P.K. 54·600)	323 ft.
Actual height, bottom of cunette	171 ft.
Depth of excavation	152

careful surveys and examinations." The Commission expressed belief that the construction of a canal across Nicaragua "is entirely feasible," and the opinion that of the two routes estimated for—those known as the Maritime Canal Company's route and the Lull route—the latter is "the more desirable, because it is easier of construction, presents no problems not well within good engineering precedents, and will be a safer and more reliable canal when completed." As regards the cost of the work, the President of the Commission and Mr. Haupt agreed on an estimate of $123,000,000, but Colonel Hains thought that "about 20 per cent." should be added to this amount "in view of the increased size of the canal estimated for and the difficulties incident to work in tropical countries." The Commissioners further remarked that "the work necessary for an exhaustive discussion and report upon the entire Canal problem is being pushed as rapidly as its great magnitude permits," and that "some meteorological and hydrological observations are still continued in Nicaragua with a view to obtain a full year of observations of that nature."

It will be observed from the above summary that as early as December, 1898, the Commission had practically determined to recommend a route which has been proved over and over again to be of doubtful utility and beset with dangers, manifest and suspected—and this in spite of its admitted understanding that the law by which the Commission was constituted required that "all routes heretofore proposed, having any merit, are to be considered, new routes that appear to have merit are to be developed, and the entire region of canal possibilities to be examined with sufficient thoroughness to enable a just and comprehensive comparison of the various routes to be made, and the most desirable one selected." Having achieved such a programme two years ago, there seems no good reason, technical at least, why the promised report has yet to be presented. For this delay we must seek explanation in the vagaries of American politics, to say nothing of the unpleasant and circumstantial rumours, discounting whatever value the interim report may possess, which came to the ears of the author more than a year ago in well-informed political and engineering circles in Washington and New York.

While the Commission was yet sitting, politicians were busily occupied in forcing its hands. Early in 1899, the United States Senate passed a bill having for effect the construction by the Federal Government of a canal through Nicaragua. This very remarkable measure provided that a canal should be built, within six years after the passage of the Act, by the much-involved and concessionless Maritime Company. Of the capital stock of the company ($100,000,000, in $100 shares), $925,000 was to be taken up by the Secretary of the Treasury, the balance being assigned to the Governments of Nicaragua and Costa Rica. The Bill further provided that of the seven directors, five should be appointed by the President of the United States, and one each by the Central American Republics; that the cost of the work, which was to be constantly and immediately supervised by the Engineer Department of the United States Army, should not exceed $115,000,000, the payments in any one year being limited to $20,000,000; that the contractors employed should be citizens of the United States; that the neutrality of the Canal, when completed, should be guaranteed by the United States; that, in the event of any failure of the project, the President should be authorised to negotiate for the control of, or the right to construct and perpetually control, some other inter-oceanic canal, and that, in any case, he should make effort to secure the abrogation of any treaty obligations restrictive of such ownership and control. The two last-mentioned provisions, it may fitly be noted, were adopted as an amendment to the Bill almost at the eleventh hour, and hint pretty broadly at the possible failure of the Nicaragua project, and the ultimate and consequent desirability of acquiring the Panama route and works. From the Senate the Bill passed to the Committee on Interstate and Foreign Commerce of the House of



THE PANAMA CANAL.—LONGITUDINAL SECTION OF THE PROJECT RECOMMENDED BY THE INTERNATIONAL TECHNICAL COMMITTEE.

Representatives, which reported it back to the House with the recommendation that "all after the enacting clause be stricken out" in favour of the text—amended in some particulars—of "House Bill, No. 11095." The Committee very severely criticised the propositions that the United States Government should pay $5,000,000 to the Maritime Canal Company, "inject itself into that corporation," and, "thus masquerading, do a work that it is in every way capable of doing in its own proper person." "It is," added the report, "claimed that under the last clause of article 48 (of the Cardenas-Menocal concession) the company would have the right to demand further time, because of the great capital invested in the enterprise." This Committee has made diligent inquiry to ascertain the amount of money the Maritime Company has expended, but nothing more definite has been learned than the statement of the president of the Company that the latter has had in its treasury during its entire existence about $1,009,000. . . . Everything in connection with the subject is uncertain except that its value is infinitesimal in comparison with the sum of $5,000,000." The House endorsed, by the adoption of this report, the animadversions of its Committee, and advantage has since been taken to shelve the question pending the Presidential election, future action concerning the Hay-Pauncefote Convention and the publication of a full report from the Walker Commission.

To the proceedings of the American Legislature arising out of the signature of the Hay-Pauncefote Convention, the author proposes to devote but a minimum of space. Public opinion in Great Britain has endorsed—very properly, no doubt—the action of the Ministry in recognising and seeking to allay the long-standing irritation caused to Americans by the existence in its original form of the Clayton-Bulwer Treaty. But we had a right to look for a more gracious reception of our advances than has actually been vouchsafed, and we cannot ignore the fact that a very considerable and influential section of Americans clamour for a canal which shall not only be constructed and controlled by their Government, but be openly used as a means of stimulating their own commerce at the expense of England. In extenuation of the amendment to the Hay-Pauncefote Convention, reported to the Senate by its Foreign Relations Committee, something may be said, and no serious harm would probably have resulted from its incorporation in the Treaty. On the other hand, very positive danger is foreshadowed by the Bill introduced into the House of Representatives by Mr. Hepburn, chairman of the Committee on Interstate and Foreign Commerce, and the author of the report unanimously adopted by that body in favour of a measure for constructing a Nicaragua Canal, in defiance of the Clayton-Bulwer compact, as a purely American enterprise, to be held by the United States in peace as in war, and defended against all comers. Mr. Hepburn, and those who think with him, would not only fortify the Canal for war, but impose in peace discriminating tariffs on non-American shipping. It is well to remember that such views may have to be reckoned with in the near future, and that they are in every way as potent as the recent official recognition of the Clayton-Bulwer Treaty and its binding force.

Among the illustrations to this article will be found a plan of the three divisions of the route which must be followed, more or less closely, by any ship-canal constructed across or on the confines of Nicaragua. As now mapped out, the total distance from ocean to ocean is 174 miles, of which at least 50 would be excavated channel and 80 San Juan slack-water requiring careful navigation. Consequently, the time required for transit, under normal conditions, could not well be less than 31 hours, and has even been estimated by some not unfriendly authorities at 44 hours. To the technical details of the project it would at the present moment, and pending some fuller information than has yet been offered by the Walker Commission, be idle to devote serious consideration, for every American expert of weight, unfettered by political influence, has united in the opinion that very exhaustive studies are essential before

it can be admitted that such a canal is feasible. In truth, the condition of the scheme, as now revealed, may be not unfairly summed up as an agglomeration of hasty or discredited surveys, projected works which offend the first principles of sound engineering, a virgin forest, a mile or so of dredging in low, swampy ground, a filled-up channel on the foreshore of Greytown, a summit lake threatening to drown everything around it, and a clayey soil which might, at points where superstructures are essential, and when subship-canal; but in quite modern times there has grown up an impression that Nature here raises some mysterious, invincible barrier to human ingenuity and ambition. That there are great difficulties to be overcome goes without saying, but in the Isthmus of Panama, as elsewhere, it has been found that insufficient study and hasty conclusions lie at the base of failure.

It was in 1878 that the Panama project came prominently before the world as a question of practical politics. Two years earlier, as the result of much discussion

AT WORK IN THE EMPERADOR CUTTING, 45 METRES ABOVE SEA: SHOWING THE TRAVELLING CABLE-WAYS NOS. 4, 3 AND 2.

jected to the effects of undercutting water, easily bring about a stoppage of navigation. The one practical substitute for this scheme, and its many objectionable features, technical, economic and political, is the once much-debated and now almost ignored Panama enterprise. To geographers and the lay public, the narrow isthmus, no wider than 42 miles, which lies between Colon on the Atlantic side and Panama on the Pacific, has always appeared the ideal site for an interoceanic

at geographical conferences, the Paris Society of Commercial Geography nominated a special committee, with M. Ferdinand de Lesseps as president, to study the question, and about the same time a syndicate was formed for the purpose of organising an expedition to conduct inquiries on the spot. Acting for this syndicate, M. Bonaparte-Wyse, in 1878, obtained a concession from the Government and Legislature of Colombia providing for the opening of a canal within

twelve years from the formation of the company undertaking its construction. This was followed, in May, 1879, by an International Congress held in Paris, which first examined the question in sections, and then in full session, voted resolutions affirming the feasibility of constructing an interoceanic ship-canal, at sea level, between Colon and Panama, within twelve years and at a total cost of 1,200,000,000 frs. (about £48,000,000). It is worthy of note that even at this time grave misgivings were entertained concerning the proposed level, and that, while many delegates abstained from voting, others supported an amendment which sought to reserve power to construct a lock-canal in the event of great difficulties being encountered in the case of the scheme approved.

A first attempt to float a company having failed, M. de Lesseps, with other experts, started for the isthmus, whence they returned, in February, 1880, with a glowing report to the effect that the Canal might be opened for traffic in eight years at a cost of only 843,000,000 frs. In the following October "La Compagnie universelle du Canal Interoceanic du Panama" was legally incorporated, and when the subscription lists closed on December 9 it was found that the public had applied for more than twice the capital asked for, viz., 300,000,000 frs., in shares of 500 frs. Within six years, in spite of strenuous efforts made to conceal the truth, it became manifest that the Canal as projected would never be realised, and in January, 1887, de Lesseps and his *confrères* swallowed their pride by laying before the "superior consultative committee" the question of a lock-canal. This action resulted in the adoption of a new scheme, the "projet d'un canal provisoire à écluses," but meanwhile the discredited company drifted to inevitable, scandalous, collapse. We all remember the grievous details of this terrible *débâcle*, but of the extraordinary and meritorious efforts which have since been made to redeem the past and evolve success from failure the world has been strangely neglectful.

M. de Lesseps and his colleagues having resigned, the company applied to the President of the Civil Tribunal of the Seine to nominate provisional administrators, and a few weeks later, on the requisition of the general body of shareholders, M. Brunet was appointed official liquidator, with very extensive powers. This gentleman, since deceased, was naturally anxious to prevent the forfeiture of the valuable rights accruing from the concession of 1880, and the consequent loss to the bankrupt company and world at large of the fruits of many years' expensive and more or less successful labour. He accordingly constituted a "Commission d'études," under the presidency of M. Guillemain, Inspector-General of Bridges and Roads, to inquire into the existing condition of affairs, and establish, if possible, the bases of a new scheme susceptible of being realised within reasonable limits of time and expense. This committee sent delegates to the isthmus, and in May, 1890, united in a report, which evinced very careful study of the question, and induced the liquidator to despatch M. Bonaparte-Wyse to Bogota to there negotiate with the Colombian Government for an amendment of its original concession. M. Wyse found the Colombian authorities sufficiently conciliatory, but it was not until 1894 that a new company was formed to assume the rights and duties of de Lesseps' ill-fated enterprise.

"La Compagnie nouvelle du Canal de Panama" was definitely and legally constituted in October, 1894, with a capital of 65,000,000 frs. in 100 fr. shares, of which the equivalent in cash of 600,000 shares and 50,000 fully-paid shares went to the Government of Colombia, in accordance with the understanding arrived at four years earlier. The South American Republic, on the other hand, officially recognised that the new company had fulfilled all the prescribed conditions; and thus—just eleven days before the original concession would have expired—all rights secured by it were prolonged for ten years. Having come into possession of all the assets of its predecessor, the new company lost no time in re-starting work on the isthmus, and in devoting itself to the serious study and

solution of the grave problems with which it was surrounded. For the latter purpose the directors summoned to their aid a technical committee of fourteen experts, representing France, England, the United States, Germany, and Russia, and possessed of experience specially fitting them to advise upon the design of the Canal and the method of its construction. It also became necessary in 1898, in accordance with article 75 of the Act of Incorporation, to appoint a special technical commission to pass judgment upon the work already accomplished and the general prospects of the enterprise. To the recently issued and remarkably exhaustive and careful reports of these two bodies, the author hopes on another occasion to have occasion to revert; for the present, it must suffice to indicate what has been already achieved, and is now being done towards the solution of probably the gravest problems encountered by modern engineering.

The Canal, as projected by de Lesseps' company, was to start from the northern extremity of the Bay of Limon, follow the valley of the Chagres as far as Obispo, divide the chain of the Cordilleras, and thence traverse the valley of the Rio Grande to the Bay of Panama—all at the normal level common to both oceans. With regard to ocean levels, many people hold strange ideas, and it may consequently be well to mention that whereas the Bay of Limon is practically tideless, the Bay of Panama experiences a tidal range of 6 metres, or 19⅝ ft.—in other words, the water may fall 3 metres below the mean level, or, at spring tides, rise an equivalent distance. The water-way was to be 9 metres (29½ ft.) deep and 22 metres (72 ft.) wide, and a great dam was proposed at Gamboa to regulate the flow of the Rio Chagres, which was to be carried to the sea in open channels alongside the Canal. It, however, has been made clear by the investigations of recent years that at no period of the old company's existence had the fundamental difficulties of the enterprise been adequately studied or properly esteemed. Of

AT WORK IN THE EMPERADOR CUTTING, LOOKING TOWARDS PANAMA: SHOWING THE TRAVELLING CABLE-WAYS NOS. 2 AND 3.

these, the first to be mentioned is the chain of the Cordilleras, which must be divided, in the case of a sea-level canal, by a cutting 110 metres (360 ft.) deep, in that of lock-canal by one at least 70 metres (230 ft.). This, however, it should be added, though involving labour both costly and prolonged, raises no special technical problem. The second is the Rio Chagres, a body of torrential water, subject to violent floods, through which the Canal for a great part of its length must necessarily pass, and against which the works must be protected and the security of navigation assured by a complete system of control. Both these difficulties tend to increase as the proposed level of the Canal is lowered, and would naturally be most pronounced in the case of a sea-level water-way. A third problem, that of feeding the Canal, which becomes more and more grave as the summit level is raised, has also to be considered in connection with a lock-canal, for, during a considerable part of the year, the inconstant Chagres and other streams along the route would fail to provide a water supply in any degree adequate for the many requirements of the enterprise. In consequence of the irregularity of its flow and the violence of its great floods, it is idle to dream of impressing the Chagres into the service of the Canal by utilising its bed; nor, owing to the enormous cost of such an undertaking and its doubtful results, can much be said in favour of the idea, seriously mooted in the days of the old company, of diverting the river from its present course and throwing it down the Pacific slope far from the route of the Canal. The only expedient (and the one best calculated to menace the safety of the works) which at any time appealed to de Lesseps and his colleagues was to create above and alongside the Canal an artificial bed for the river, for the purpose of draining off at certain periods of flood considerable quantities of water. When, at length, the sea-level project was renounced in favour of the inevitable and unwelcome locks, a partially new and ill-digested scheme was hastily adopted. The "divide" was to be raised by placing the bottom of its summit level 40 metres above sea, thereby reducing by 50 metres the depth of cutting; on each slope five locks were projected, with chambers of 180 metres working length; and all difficulties as regards alimentation were to be swept away by the employment of engines for driving the water into a reservoir formed by a dam at Gamboa, a site subsequently described by the "Commission d'Etudes" as "one of the least satisfactory that could have been selected." Concerning the control of the unruly Chagres, little appears to have been thought and nothing determined.

Such, briefly put, was the technical position at the time of the collapse. It was moreover made manifest, as the investigation proceeded, that of the 180 metres of earth and rock which required to be cleared at the summit of the Culebra pass, 20 only had been touched; that the dam projected at Gamboa, for the purpose of holding back a portion of the Chagres floods, had not even been commenced, and that the channels dug alongside the Canal, destined to drain away what the reservoir could not retain, were so constructed as to raise doubts as to whether they would have been qualified to effect their purpose. Everything combined to show that the conceptions and work of the old company had failed to offer any satisfactory solutions to the three most important problems connected with its enterprise. Yet upon, or rather in connection with, this latter, no less than £60,000,000 had been frittered away.

Very different have been the tactics pursued by its successor. Adhering not only to the letter, but also to the spirit, of its statutes, the new company has religiously devoted itself to the acquisition of data bearing upon every difficult problem and the most minute detail of its work. To secure these, it has spared neither time nor money, as witness the *cunette preparatoire*, or exploratory longitudinal boring, through the Emperador and Culebra peaks, a task no less desirable than satisfactory in result, for it has demonstrated that the strata through which the Canal cuttings will pass in the region of the Cordilleras are of such a nature as to dissipate all fears of slips or landslides. Moreover, under the direct

supervision of the Technical Committee, the whole of the Canal route and collateral works have been accurately re-surveyed and contoured, all the streams in the vicinage have been gauged, innumerable trial pits have been sunk and borings made, and a mass of meteorological observations have been recorded—nothing has been left to chance or dependent on hypothesis. Of the operations of the International Technical Committee, it is impossible to speak except in terms of warmest eulogy. In dealing with the various problems before it, the Committee laid down three principles from which it refused to depart: (1) To set aside every solution which did not offer, in itself, substantial guarantees of success; (2) that, as regards solutions of technical problems, it must consider only those which permitted of applications already sanctioned by experience, and must reject all innovations possibly leading to error; and (3), that it was essential, before adopting any solutions, to take into full account surrounding conditions and the influence of the climate both upon workmanship and the directing *personnel*—in other words, that works only of a simple type, the execution of which would call for no exceptional conditions, should be contemplated.

As a result of this painstaking and laborious research, the company is now able to face the world and invite universal criticism with a project for completing a lock-canal across Colombia, which, it is claimed, is technically correct and can be thrown open to traffic in ten years at a cost of 512,000,000 frs. (£20,480,000), inclusive of administration expenses and interest paid out of capital during the period of construction. Within the limits of such an article as the present, it would be obviously indiscreet to attempt any detailed description of the project, or even its most salient points. Of its general character, however, some idea may be gathered from the map of the route and longitudinal section printed on other pages.

No reason was found for departing, except in very minor details, from the route proposed by M. de Lesseps; consequently advantage can be taken of all the excavation accomplished by the old company. This is indicated in the longitudinal section by the unshaded spaces below the original earth-line; the diagonal shading shows by comparison the amount of earth and rock which has still to be removed, while the cross-shading in the region of the Cordilleras, between the kilometre posts 48 and 55·500, and in the Bay of Panama, mark what had been achieved by the present company in the matter of excavation and dredging up to November, 1898. So far as actual work towards the completion of the Canal is concerned, attention during the past few years has been chiefly concentrated upon the great Emperador and Culebra cuttings—in the first place, because they are essential features of any project for canalising this portion of the isthmus; and, secondly, in order to demonstrate by actual experience that no fears need be entertained regarding the stability of the soil, however deep the cuttings may be carried.

In the project recommended by the Technical Committee it is proposed that the central cutting, embracing the Emperador and Culebra peaks, should be excavated to a point 20·75 metres, or 68 ft., above the mean level of the oceans. This would be the summit level or "divide" of the Canal, and call for the removal here alone, in addition to all that has been already accomplished, of over 20,000,000 cubic metres of earth and rock. To effect the descent to the ocean on each slope four locks are contemplated—on the Atlantic side, two groups of two locks each at Obispo and Bohio; and on the Pacific side, one lock at Paraiso, a flight of two locks at Pedro-Miguel, and a single lock at Miraflores. All the locks will be double, with parallel chambers 82 ft. wide and a working length of 738 ft., and the maximum lift contemplated is 29½ ft. The minimum draught of water throughout the Canal will be 9 metres (29½ ft.), and the width at the bottom will vary in the different levels from 30 to 60 metres.

One of the most prominent features of the scheme for regulating the Chagres floods is the closing of the valley of the

Lower Chagres, near the kilometre post 24, by means of a great water-tight dam, largely composed of puddled clay and 392 metres long measured at the crest. This would create, behind the Bohio locks and extending thence as far as the Obispo locks, a vast lake, which would impound and render not only innocuous but actually serviceable the bulk of the hitherto turbulent and dreaded floods—it would, in fact, serve as one of the reaches of the Canal. Moreover, near Alhajuela, some 9½ miles north-east of the lines of the Canal, in a rocky and constricted gorge, through which the Upper Chagres flows, another massive dam, in this instance of concrete, is contemplated. Behind this a second great lake will be formed for the storage of flood water, which, brought down to the "divide" by a "rigole d'alimentation," or feed-water conduit, can be used as required for the service of the Canal. This Alhajuela dam, as planned, would be 285 metres long at the crest, 50 metres wide at the base, and 51 metres in height at the centre and deepest part of the valley; its foundation would be 19 metres above the mean level of the oceans, its crest 71 metres above the same point, and the maximum levels of available reserve and flood-water impounded by it would be respectively 64·50 metres and 68·00 metres above sea-level. For the purpose of carrying up material, etc., to the works connected with the dam and feed-water conduit a railroad, joining the P.R.R., would be constructed from Gamboa. In consequence also of the flooding of the region between Bohio and Obispo, a considerable deflection of the Panama railroad is contemplated. The deviation would commence near the site of the Bohio dam and join the existing line at Miraflores, thus bringing the entire length of the railroad to the left bank of the Canal.

Particular attention is invited to the photographs of scenes along the route of the Canal, which are included in this article. These photographs, all of which were taken at Culebra or Emperador as recently as November 25 of last year, are especially interesting on account of the unquestionable proof they afford of the falsity of current beliefs that the Panama Canal may properly be regarded as an abandoned enterprise, and, consequently, negligable quantity. The present author not only fails to share such idea, but looks forward hopefully to the day when it shall be generally conceded that the great problem has been solved which has vexed four centuries of civilisation. Long before this arrives, however, one point will have to be seriously considered, and that is whether British commerce is to freely participate, on equal terms with that of all other nations, in the benefits of the future. So far as the present Panama Company is concerned, we need have no fear of disloyalty to the sound principle that any isthmian canal should be neutral territory, free on identical terms to the ships and commerce of all nations. But this company, it should be remembered, already occupies the position of seller and it therefore behoves British statesmen to well weigh the consequences, not remote, of its property passing under American control. While these words are being written negotiations to this end are actually in progress at Washington.

John Geo. Leigh

Electrical Methods of Heating as Applied to the Working of Metals.

By G. W. De TUNZELMANN, M.Inst.E.E.

(Continued from page 400.)

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The voltex process of electric heating can in many cases be used with advantage for riveting. In the ordinary method of riveting ship and boiler plates the rivet is heated to redness throughout, and inserted in the rivet holes, after which its unformed end is hammered down into a head by means of a hollowed-out punch and sledge hammers. The disadvantage of heating the rivets to redness throughout is that it expands them both longitudinally and laterally, and when they contract, owing to the longitudinal contraction being greater than is required to tighten them in position, they are subject to an excessive tensional strain, which considerably weakens them, and sometimes even strips the head at one end. Owing, moreover, to the lateral contraction, the rivet when cold does not completely fill the rivet-hole.

In riveting by this electrical process the rivets are inserted cold, and the unformed end is then heated by directing the arc upon it for a few seconds, when it is hammered over in the usual way, the body of the rivet never having been raised to anything like a red heat, except just near the end, so that the evil effects of contraction are almost entirely obviated.

Another very important application of the process is to brazing and soldering, especially brazing.

Brazed joints made in this way are found to be considerably stronger than when made by coke and gas, the cases which have been most carefully tested being the joints of steel wires for wire rope-making, and cycle joints, both of which show a most striking increase in strength when brazed in this manner.

The great strength of the joints, which is a noteworthy feature of electric brazing, should make it most useful for brazing band-saws, where the greatest attainable strength in the joint is of the utmost possible importance. It should also be of considerable value in fitting up and repairing copper steam pipes on board ship and elsewhere, as whenever the joint in fault is accessible the brazing can be done without removing the pipes.

Another great advantage for cycle work, and much other brazing, is the fact of the flux being all driven off in vapour, leaving the joint clean and free from the hard scale which requires so much labour, and wear and tear of files, to remove when cycles are brazed in the ordinary manner by the aid of coke and gas.

The following comparative table will be of interest in illustrating the effect of the absence of scale on the cost of cycle brazing by this method :—

COST OF BRAZING AND FILING UP A CYCLE FRAME.

By the Gas and Coke Process.

With Gas at 2*s.* 10*d.* per 1,000 cub. ft.

	s.	*d.*
320 cub. ft. of gas	1	1
Wages 1½ hrs. for brazing, at 9*d.* per hr.	1	1½
Wages 4 hrs. and 20 mins., for filing off at 8*d.* per hr.	2	10½
Wear and tear of files, air blast, and coke	0	8
	5	9

By the Voltex Process.

With Electricity at 3*d.* per Board of Trade unit.

	s.	*d.*
1½ unit of electricity	0	4½
Wages 50 mins. for brazing, at 9*d.* per hr.	0	7½
Wages 1 hr. for filing off, at 8*d.* per hr.	0	8
Consumption of patent carbon electrodes, and wear and tear of files ...	0	2½
	1	10½

FIG. 19.—THOMSON ELECTRIC WELDING PROCESS: A TYRE IN POSITION READY FOR WELDING.

Another application which should be of considerable value is for what is known as lead-burning, that is, joining together lead plates or tubes without the use of solder.

In making up accumulators, for example, it would not do to use solder for the joints, as the acid would attack the zinc and tin in the solder and ultimately destroy the joint. The joints are now usually made by melting the two pieces to be joined by means of the oxyhydrogen flame, which does the work satisfactorily, but the electrical process would be considerably cheaper, and quite as convenient and simple to use.

It should also find a considerable field for making joints in electric wires and cables, which would be far superior to those in which solder is employed. In electric traction, in cases where the rails are used as the return lead of the circuit, this process would be the ideal one for making the bonds between the rails, whether by the method which finds much favour in the United States, of melting steel in between the ends of the adjacent rails, or by connecting the ends by means of flexible copper bonds.

The latter process is preferred in this country, as when the former one is employed there is no allowance for expansion and contraction with changes of temperature.

If the rails are supported on cross sleepers not more than a yard apart, or have continuous longitudinal supports, calculations show that, even assuming the rails to be kept from bending in a horizontal plane, as is the case with tram rails imbedded in the road material, the strains brought into play do not exceed the elastic strength of the steel rails, unless the joints are considerably weaker than the rest of the rails.

This is confirmed by practical experience. More than 20,000 joints were

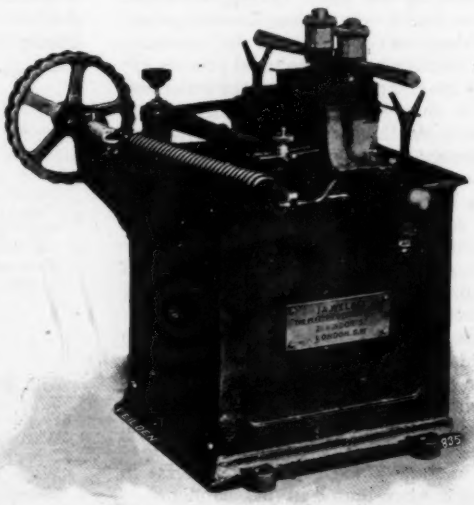


FIG. 18.—SMALL THOMSON AUTOMATIC ELECTRIC WIRE WELDER.

made in 1895 on the Chicago tram-lines by simply pouring cast metal between the rails which would not give so good a joint either electrically or mechanically as would be attained with electrically-fused steel. In spite of this and of the very large temperature range only 1·23 per cent. of the joints gave way, all during the first frost, and in every case of failure it was found that the joint had not been properly made in the first place.

With regard to a possible deformation in the vertical plane, calculation shows, in the case of ordinary tram rails, the weight alone is enough to prevent it unless the radius of curvature in the vertical plane falls below 1,000 metres, and then all deformation will be prevented if the rails are supported on cross sleepers embedded in the roadway at intervals of not more than a yard.

The writer is not aware of electric welding having been applied to the permanent way of an ordinary railway where the rails are not embedded in the road but merely rest on sleepers. Brunel, however, in 1851 called the attention of the Institution of Civil Engineers to an experiment which he had made by riveting up about a quarter of a mile of rails supported in the ordinary way on sleepers into a continuous length, and in which no deformation could be detected.

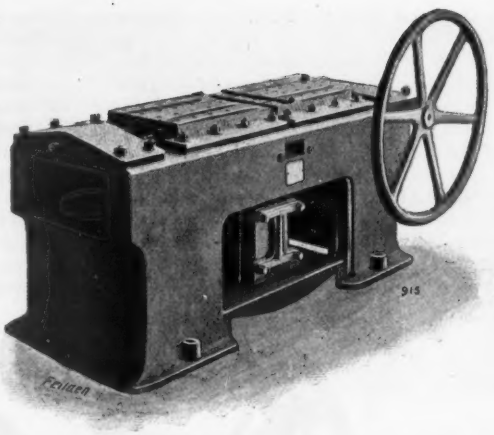


FIG. 20.—MEDIUM SIZE THOMSON ELECTRIC WELDER.

American experience with tram-lines which have been continuously welded together is that the cars run much more smoothly on them than on the lines where the usual allowance is made for expansion and contraction.

The copper bonds, when that method is employed, are at present usually simply bolted to the rails in such a manner as to spread the contact over a large surface; but the joints would be of lower electrical resistance and far more lasting if they were electrically burned together. Flexible iron bonds might be welded on in this manner, and this would obviate electrolytic action.

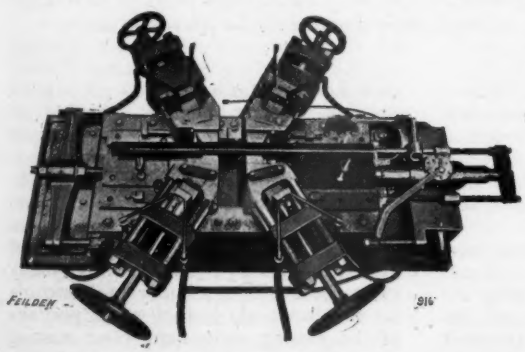


FIG. 21.—TOP OF LARGE-SIZE THOMSON ELECTRIC WELDER, WITH HORIZONTAL OBLIQUE CLAMPING DEVICE, AND HYDRAULIC JACK FOR UPSETTING.

The larger apparatus might be used by divers for cutting rapidly through large chain cables or iron plates under water, where the arc works perfectly well for this purpose, the reason that it is not cooled down as much as might be expected by the water, being, that its intense heat turns the water surrounding it into steam, so that the arc

is insulated from the water by a cushion of vapour.

Very small tools, taking carbons only 7 mm. in diameter, are made for fine brazing and for jewellers' work, such as making the joints in rings. It should be of special value in working platinum, which melts readily, or merely softens, according to which portion of the flame is applied to it, and for many kinds of fine work in the precious metals it would be far more convenient than the appliances at present in use.

chipping up rough castings is by no means one calling for highly-skilled labour, though it requires practice

These men, of course, require intelligent supervision and direction. In the case of steel the difficulty increases with the proportion of carbon in the steel, and this applies to both processes, for, as the proportion of carbon increases, the steel not only becomes more fusible, but the interval of temperature between the non-welding point and the burning point becomes smaller, and therefore greater

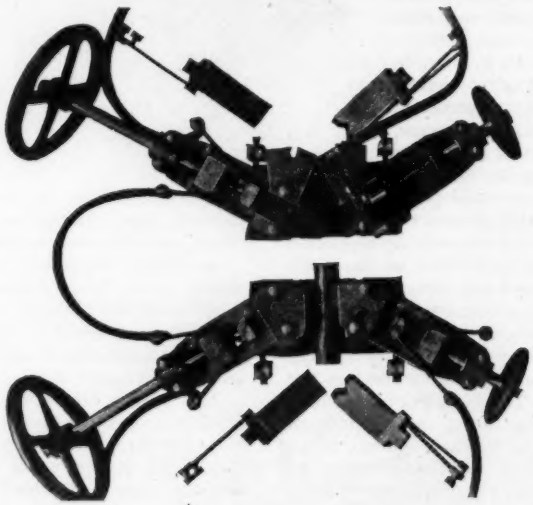


FIG. 22.—DETAILS OF THE CLAMPING DEVICE USED ON LARGE-SIZE THOMSON ELECTRIC WELDER.

Both in the Benardos and the Voltex processes a good deal of care and skill is required on the part of the operator in order to obtain good results; but this does not, as might be supposed, involve the employment of very expensive labour.

In the case of two important steel works near Newcastle-on-Tyne, one employing the Benardos and the other the Voltex process, the writer has been informed by the managers that all the work is done by men selected from the cleaners or chippers. Their ordinary work of

care has to be exercised to get a good junction without burning, whether in welding bars or in filling up flaws in castings.

In the case of cast-iron the chief difficulty arises from its very large contraction. This sometimes makes it impossible to repair castings which, but for this, would offer no difficulty; but in very many cases these difficulties may be overcome by simultaneously heating other portions of the casting, or in some cases heating the whole casting in a furnace before applying the arc.

THE THOMSON PROCESS OF ELECTRIC WELDING.

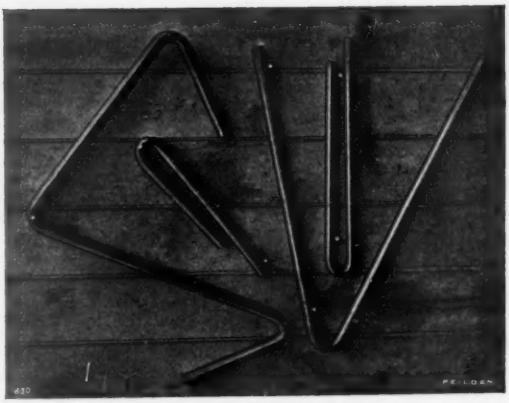


FIG. 23.—TUBE JOINTS MADE BY THE THOMSON ELECTRIC-WELDING PROCESS.

The principle of the method of welding invented by the American Professor, Elihu Thomson, consists in passing a very large current of electricity through the junction of two metal bars or tubes to be butt-welded. The resistance at the joint being very much greater than that of the unbroken metal, the greater part of the heat due to the passage of the current is developed at the joint, and if a sufficient amount of current is employed the joint may be rapidly raised to welding heat. When this is done the two bars or tubes are pressed together, usually by means of a screw, which forces out the softened metal at the joint, forming a burr round the junction. In order to obtain good results, this burr, and the portions of the tube, or bar, adjacent to the joint, should be hammered in swages, in order to strengthen the joint by laying the grain of the metal along the length of the tube or bar, as it is at other portions. As the two portions of metal weld together the resistance due to imperfect contact diminishes; indeed, from measurements made by Professor S. P. Thompson, it would appear that the resistance at the joint after welding is not sensibly higher than that of other portions of the bar. In spite, however, of the improving contact, the resistance of the joint will remain comparatively very high as long as the current is passing, because of its high temperature relatively to that of the other portions of the bar or tube, and therefore the chief development of heat continues to take place at the joint until the current is shut off. One important effect of this increase in the resistance of metals produced by rise in temperature is that if, owing to want of homogeneity in the metal, or of uniform contact across the joint, some parts of the joint begin to heat more rapidly than others, the comparative coolness of these portions will cause a relative increase in the flow of current through them, the result being a tendency to make the heating far more uniform throughout the joint than would otherwise be the case.

The current is conducted to the metal on each side of the joint by means of massive copper clamps. As the resistance to the joint, although high relatively to that of other sections of the metal to be welded, is in itself small, a pressure of from one to two volts, or even less, is sufficient to send all the current required across the joint. The very low pressure required is usually obtained by transforming down the current obtained from an ordinary alternating current dynamo on the premises, or from a central station. The secondary circuit of the transformer is, in the larger machines, usually formed of a single massive copper casting; this casting, as well as the massive copper clamps which carry the current to the bars or tubes to be welded, and which are made hollow for the purpose, are kept from over-heating during the operation by maintaining a continuous flow of cold water through them.

Fig. 18 shows a small automatic electric wire welder, as used by the Electric Welding Company, Limited, for welding together the copper, steel and iron wires used in the manufacture of electric

cables. Their engineer, Mr. Wallis-Jones, has recently designed an improved and more efficient transformer for this type of welder.

One jaw of this apparatus is fixed, while the other is movable. The pressure of the spring shown in the illustration, and which is adjustable, tends to cause the movable jaw to approach the fixed one. When the metal is sufficiently softened by the heat, the movable jaw slides, and an automatic switch comes into operation, the button of which is visible near the wheel used for adjusting the strength of the spring.

To suit different gauges and qualities of wire the amount of upsetting can be varied, and also the time during which the current is allowed to pass through the joint.

Another type of Thomson welder is shown in Fig. 19, with a tyre in position for the welding of its ends together. Below the platform is seen a copper casting of rectangular section, in which the primary coil of the transformer is embedded. The two ends of the secondary are brought up to the platform, where they are attached to suitable vertical clamps. This machine is used for light tyres, straight bars, angle, ring, and miscellaneous work. Its maximum welding capacity is 0·3 sq. ins. cross section of iron or steel, which takes 9 h.p. for 25 secs.

It might be supposed that in welding tyres and other rings by this method there would be a very large waste of energy through that part of the current flowing round the ring instead of across the joint, and which does not assist in the welding, but merely beats the ring throughout. The loss due to this cause, however, is very much smaller than would appear at first sight to be the case. Not only is the resistance of the long path round the ring, in the case of a steel or iron tyre such as is shown in Fig. 19, very much greater than the resistance of the short path across the joint, but the self-induction is greater in a very much higher ratio, so that only a very small proportion of the alternating current takes the longer path. In the case of copper rings, especially when of small diameter compared with their cross-section, the resistance and self-induction are both very much lower, and a very large proportion of the energy would be wasted. Much, however, of this may be prevented by linking an iron ring or coil of iron wire with the ring to be welded, thereby increasing its self-induction.

A Universal Welder of larger size is shown in Fig. 20. The transformer is

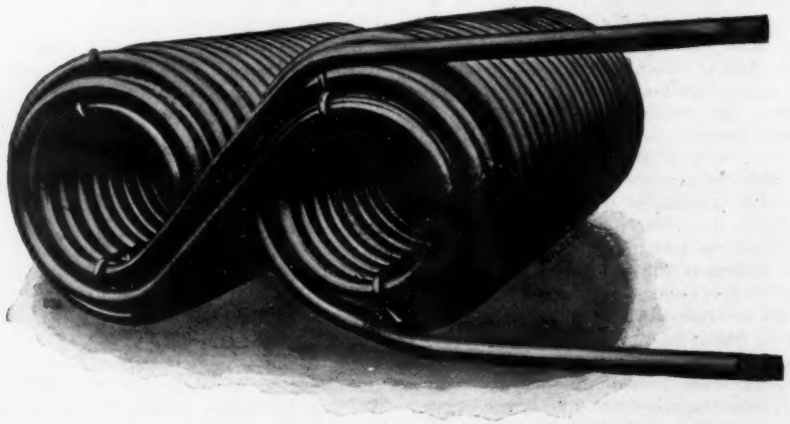


FIG. 24.—REFRIGERATING COIL BUILT UP IN SECTIONS BY THE THOMSON ELECTRIC-WELDING PROCESS.

below the platform, which carries two copper plattens, to which any clamping device that may be required can be bolted. One platten is fixed, while the other is movable by means of a screw upsetting device. The maximum capacity of this machine is 1·23 sq. in. cross-section of iron or steel, taking 35 h.p. for 60 secs.

Fig. 21 shows the top of a still larger type of Universal Welder with a horizontal oblique clamping device, and a hydraulic jack for upsetting when the metal has become sufficiently soft. A circulation of water is maintained in the copper blocks which butt on to the metal to be welded. Details of the clamping device are shown in Fig. 22.

Butt-welds made on these machines are almost invariably found to be stronger and more reliable than the hand-made scarf welds which have hitherto been universally used, and in some tests carried out by Professor A. B. W. Kennedy on wrought-iron bars varying from $\frac{1}{2}$ in. to 2 in. in diameter, the average strength of the joint was found to be as high as 89 per cent. of that of the solid bar, while with Bessemer steel bars he found it to be as high as 96·5 per cent. The process has been found of very great value in welding lengths of pipe together, and Fig. 23 shows some specimens of pipes which have been welded in this way and subsequently bent in the weld.

Messrs. J. and E. Hall, Ltd., of Dartford, are using the Thomson welding process for the manufacture of the coils of their refrigerating machines, and one of their coils which has been built up by means of this system of welding is shown in Fig. 24.

Mr. Wallis-Jones informs the writer that, according to figures supplied by Messrs. J. & E. Hall, with one-inch size screwing-pipe, the metal being a quarter of an inch in thickness, each weld is completed in one and a quarter minutes, and about two minutes are sufficient to weld one and a-half inch screwing-pipe. These pipes are tested up to 3,000 lbs. per square inch after welding, and Messrs. J. & E. Hall state that they have never yet found a joint welded in this way to be faulty.

In America the process is in extensive use for welding the rails of electric railways into continuous lengths to enable them to be used as conductors of the current, without electrolytic action taking place at the joints. The pioneers in this work were the Johnson Company, who made a long series of costly, and at first unsuccessful experiments, but ultimately found that good and durable joints could be obtained in this way, provided sufficient power were used to make the welds with great rapidity.

Quite recently the process has been very successfully applied to the manufacture of cycle, automobile, boiler, and other tubes out of thin sheet steel (from 22 to 15 B.W.G.) The side seam is made by a travelling welder. Tubes are made from half an inch to two inches in diameter, and up to fifteen feet in length.

For every particular kind of weld made by the Thomson process there is a proper speed at which it should be effected in order to ensure the best possible result. If the weld is made too quickly the metal will be burned at the point of contact, while if made too slowly the machine and clamps will become over-heated, and a considerable amount of energy will be lost by radiation. When different metals and objects of different size have to be welded together the results obtained will depend largely on their proper disposition in the clamps.

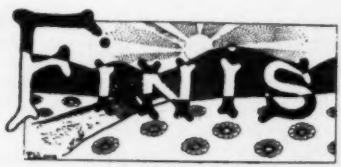
The less the pieces project beyond the clamps the less is the resistance across the joint, while the length heated is also less, causing less loss by radiation. Consequently the smaller is the amount of energy absorbed in making the weld. If, however, the projection is too small, the clamps will be over-heated and very possibly damaged.

When two bars of the same material but of different cross-sections have to be welded the smaller one would become heated more rapidly if they projected equally, and it might be supposed that, in order that both should reach the welding temperature at the same instant, the smaller one should project more, so as to leave a longer portion of it to be heated.

It is found, however, in practice that the projection of the smaller bar must be less instead of greater, this being due to the great conductivity of the copper clamps, which carry away the heat more rapidly the less the projection of the bar. Mr. Wallis-Jones has obtained very good results in the case of unequal sections by heating the larger section first to dull red heat and then bulling it on to the smaller section cold; on current being turned on, both arrive at welding heat at the junction at the same time.

For the same reason when an easily fusible metal has to be welded to a more refractory one matters can be so arranged, by making the projection of the fusible less than that of the other in the right ratio, that each shall attain its own welding temperature at the same instant.

Gold, platinum, silver, copper, aluminium, bismuth, cobalt, antimony, lead, zinc, tin, nickel, manganese, and magnesium have, in addition to iron and steel, been successfully welded by this process. Care and skill on the part of the operator are just as essential in order to get good results with the Thomson process as in the case of those described previously, except in the case of the Automatic Wire-Welder, which, being entirely automatic in its action, requires no skill on the part of the operator.



The Central London Railway.

By W. N. TWELVETREES, M.I.Mech.E.

(Continued from page 433.)

The Depôt and Generating Station of the Central London Railway are established upon a site, some 20 acres in extent, which was formerly Woodhouse Park. This pleasingly rural title is still to be found inscribed upon one of the main entrance-gates, although it is at the present time no more appropriate to the area in question than is the name of Shepherd's Bush to the surrounding locality. During the earlier stages of the undertaking the land was used by the contractors for the storage of materials and as a convenient place for the establishment of temporary workshops. All traces of such occupation have long since been removed, and the site is now for the greater part covered with boiler and power houses, locomotive and carriage sheds, workshops, and other buildings necessary for the working of the line. It should be noticed, however, that ample space still remains for the erection of any further buildings which it is likely will be required by the extension of traffic on the system.

As already mentioned, the Depôt is entered from the passenger lines by means of a branch line emerging from the inclined tunnel at one corner of the yard, the greater part the latter being covered with sidings for the marshalling of trains, and the tracks are arranged so as to give access to the various sheds at the southern side of the Depôt. The northern side is partly occupied by the boiler and power houses, constituting the Generating Station. In order that the general arrangement of the plant contained therein may be more readily understood, we give in Fig. 16 a sketch plan, on which the positions of the chief units of the installation are indicated.

The boiler-house is of red brick, the roof being of iron and slate. It is well lighted, both by windows in the walls and in the roof, and its internal dimensions are 148 ft. long by 86 ft. wide by 39 ft. from floor level to the centre of roof. There are 16 boilers, disposed in two lines facing a central gangway 20 ft. wide, whilst there are passages 10 ft. in width behind each row, and others 4 ft. 9 in. wide between each pair of boilers. The main flues pass below the floor level along the east and west walls of the boiler-house, and are continued in a northerly direction to the two chimneys, being arranged so that the products of combustion may be caused to pass through economisers or direct to the shafts. Fuel is brought directly to the boiler-house by means of a siding from the adjacent line of the West London Extension Railway, and is carried to the bunkers by a conveyor. Feed water is suitably purified, softened, and warmed before being admitted to the boilers, as will be afterwards described; and the main steam pipes are disposed in such a manner that all the boilers are under independent control, and that all the engines in the adjoining power-house receive adequate supplies of steam under any ordinary conditions of working. Space is provided for the installation of four additional boilers, should they become necessary in course of time. From the above outlined sketch it will, no doubt, be evident to our readers that the general scheme of arrangement is in every way admirable, and likely to conduce to satisfactory and economical working. Proceeding now to details, we will commence with the boilers themselves, of which drawings are given in Figs. 17, 18, and 19. Fig. 17 is a longitudinal section through the boiler-house, showing eight of the boilers, some in section and others in elevation. This figure also shows the

ashpit, and the doors and wagons for the removal of ashes. Fig. 18 includes the front elevation and cross-section respectively of two boilers and the plan of one boiler. Fig. 19 gives a longitudinal section and a section above grate level of one boiler. They are of the well-known Babcock & Wilcox type, each boiler being composed of sixteen sections of tubes, each section comprising ten tubes, 4 ins. diameter by 18 ft. long, expanded into transverse headers. Through the headers at the front end of the boiler the heated water rises by way of connecting-boxes into the two horizontal steam and water drums, 23 ft. 7 in. long by 3 ft. 6 in. diameter, where steam separates from the water, and the remaining body of water passes down through tubes at the back end of the boiler into the headers, whence it is again distributed amongst the tubes exposed to the direct action of the fire. Thus a rapid and continuous circulation is maintained, and a nearly uniform temperature is secured throughout the boiler. The headers at the back end are connected with a mud drum, 9 ft. 8 in. long by 10 in. diameter, to which the blow-off pipe is attached. The two longitudinal steam and water drums, spaced 4 ft. 8 in. apart, centre to centre, are connected at the back end of boiler by a cross steam drum 7 ft. 6 in. long by 2 ft. diameter, in the upper part of which are two blockings, one of 7 ins. internal bore, in the centre for main steam, and one of $2\frac{1}{2}$ ins. bore at the right-hand end for auxiliary steam supply. The centre blockings of each pair of boilers are spaced 11 ft. 2 in. apart, centre to centre, and are joined by a steam pipe, from the upper side of which springs an 8-in. branch connected with the main steam pipe running along the wall separating the boiler-house from the power-house. The coupling pipes, as well as the branch pipes, are all under control by valves, so that any individual boiler or pair of boilers may be shut off as desired. Each boiler has 3,580 sq. ft. of heating surface and 90 sq. ft. grate area. No tests have yet been made with the object of determining the exact duty of the boilers; but it may be taken that each is capable of evaporating 12,000 lbs. of water per hour at 160 lbs. per square inch, which is the daily working pressure. Each tube section was tested during construction to 300 lbs. hydraulic pressure, and, after erection, 240 lbs. hydraulic pressure was applied to each completed boiler. A wrought-iron gallery, supported by cast-iron brackets, runs along each line of boilers at the bottom level of the steam and

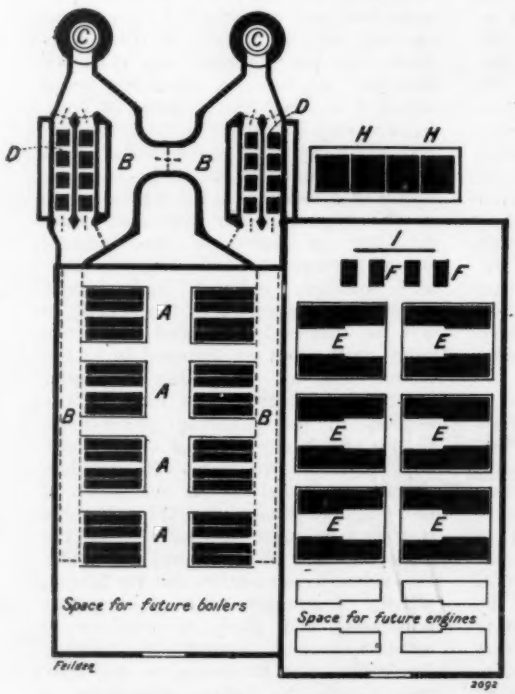


FIG. 16.—SKETCH-PLAN OF GENERATING STATION, CENTRAL LONDON RAILWAY.

A A Boilers.
B B Main Flues.
C C Chimneys.
D D Economisers.
E E Main Engines and Generators.
F F Exciter Sets
H H Cooling Towers.
I Main Switch-board.

water drums, so that access may be given to the valves and other steam fittings. These galleries are furnished at suitable intervals with wrought-iron ladders.

Mechanical stokers of the Vicars' type are applied to both batteries of steam boilers. These stokers are of the kind usually applied to water-tube boilers, and their principal features are illustrated in the longitudinal section of a boiler given in Fig. 19. After leaving the charging boxes the fuel is deposited on a coking plate by the action of reciprocating plungers, and it lies here in a mass about 12 ins. deep, being thoroughly coked before it is moved forward by the action of the grate bars. Two distinct mechanical movements are involved in the operation of the stoker—(1) the coal feed, and (2) the grate motion. The coal feed is regulated by varying the speed of the plungers, which can be instantly adjusted by a hand lever from slow to rapid, or *vice versâ*, as the exigencies of working may require. As there is a separate lever to each furnace, the coal feed of each is quite independent of the other. The grate motion consists of a reciprocating action of the grate bars, which is operated by mechanism somewhat similar to that used for the coal feed, and several intermediate variations are possible, from a state of rest to a travel of about $3\frac{1}{2}$ ins. Each furnace has two sets of bars, each set being composed of alternate bars. Both sets move forward at the same time and at the same speed, but return at different times. As a result of the arrangement the fuel is carried inward by the simultaneous movement of the bars, but it is not disturbed by the separate return of either set. With each successive movement of the bars the fuel, together with clinker and ash refuse, is carried towards the end of the grate, and it is finally deposited in the chamber below, where combustion is completed.

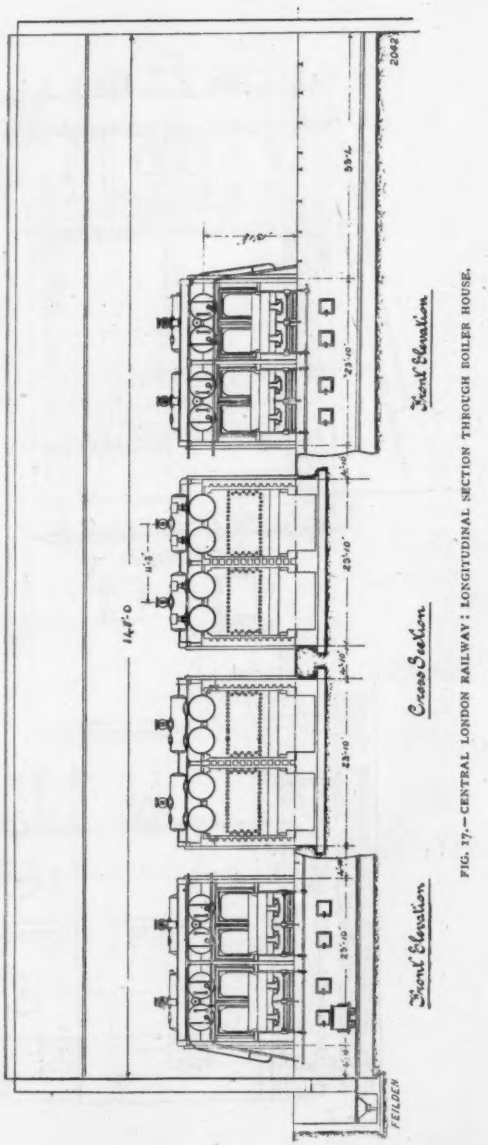


FIG. 17.—CENTRAL LONDON RAILWAY: LONGITUDINAL SECTION THROUGH BOILER HOUSE.

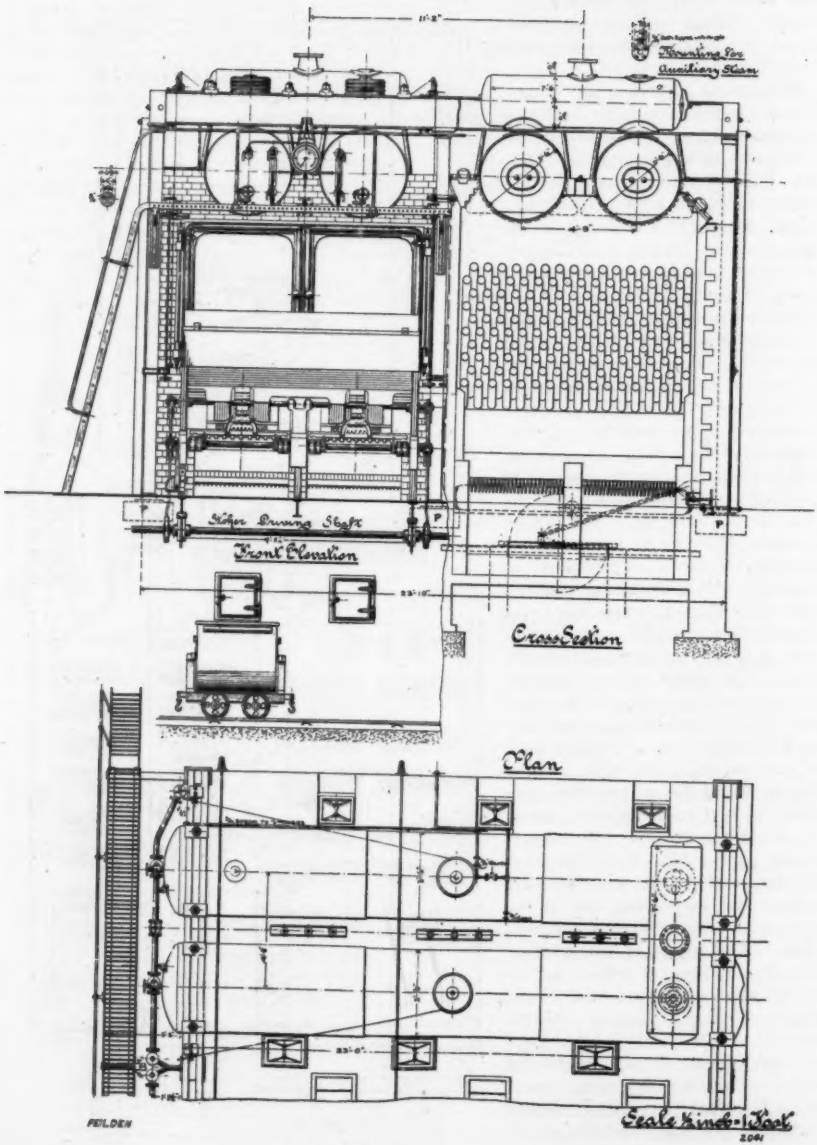


FIG. 18.—CENTRAL LONDON RAILWAY: DETAILS OF BOILERS, EACH OF 3,580 SQUARE FEET HEATING SURFACE.

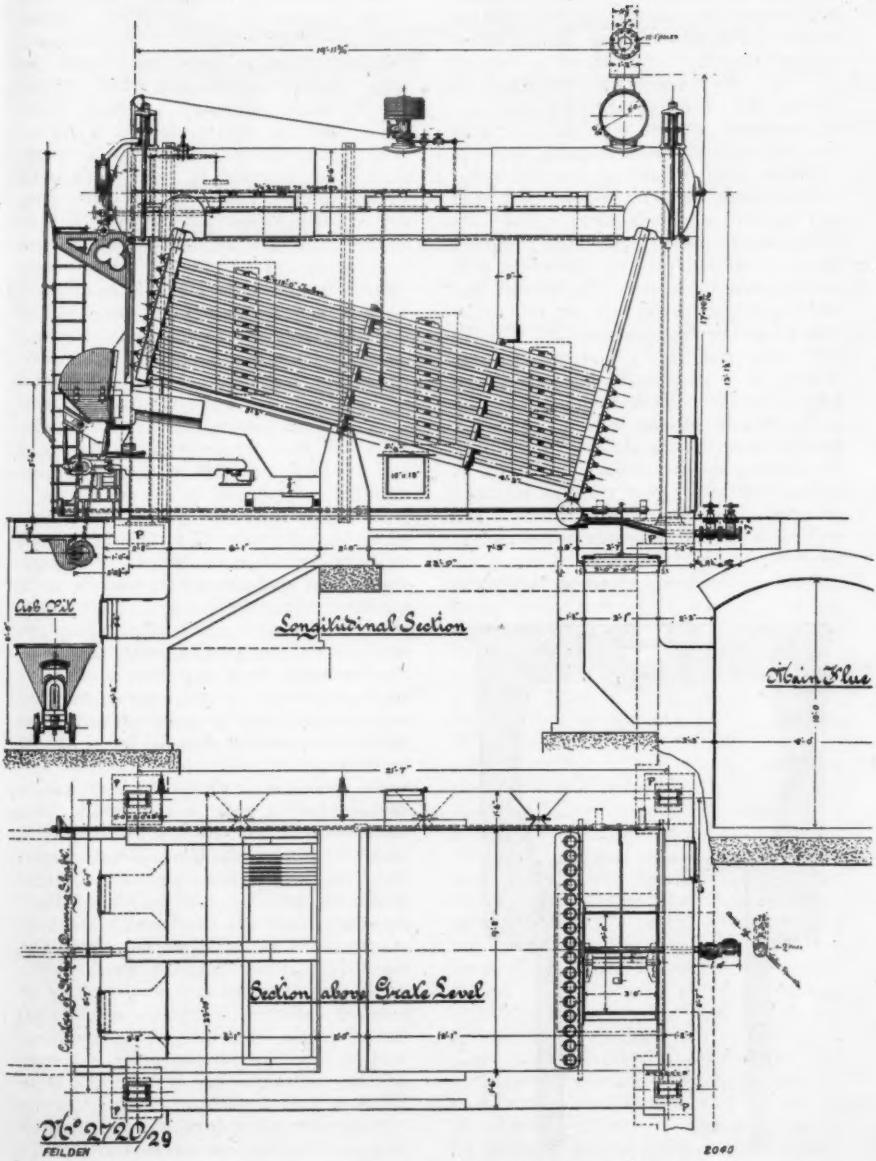


FIG. 19.—CENTRAL LONDON RAILWAY: DETAILS OF BOILERS EACH OF 3,580 SQUARE FEET HEATING SURFACE

The mechanical movements are actuated by eccentrics and connecting rods working in connection with shafting running below the boiler-house floor, as shown in Figs. 18 and 19. Two engines are provided for driving the lines of shafting, and the arrangement is such that either engine can drive either line of shafting, or both.

These engines are of the Chandler enclosed type, made by Messrs. Bumstead & Chandler, of Hednesford. They are both single crank compound engines, having 6-in. high-pressure cylinders, 9-in. low-pressure cylinders, 6-in. stroke, and running at 450 revolutions per minute, at which speed each engine develops 20-brake h.p. One noteworthy feature in these engines is to be found in the provision of large inspection doors, both at front and back, whereby all the working parts can readily be examined. At Shepherd's Bush the shafting is driven from the engines by the aid of worm gear. Steam is taken directly from the steam drums of two boilers for operating these auxiliary engines, as shown in Figs. 18 and 19.

Coal is delivered in trucks from the siding previously mentioned, and, after being weighed, it is shot into a hopper near the south end of the boiler-house, being then fed by gravitation upon the coal conveyor, which was made by the C. W. Hunt Company, of New York. The conveyor commences in a tunnel under the centre of the boiler-house floor, and extends to the north wall of the building, where it rises, and is continued under the roof so as to serve the coal bunker. The total capacity of the bunker is 1,500 tons, and it is divided into 20 compartments, one for each boiler; but as only 16 boilers are at present laid down, four of the compartments are not used. Extending over the whole length of the boiler-house, the bunker is 28 ft. in width, and is furnished with a central partition and suitable devices, by whose aid coal may be delivered through shoots into the right and left-hand divisions of the bunker, as required.

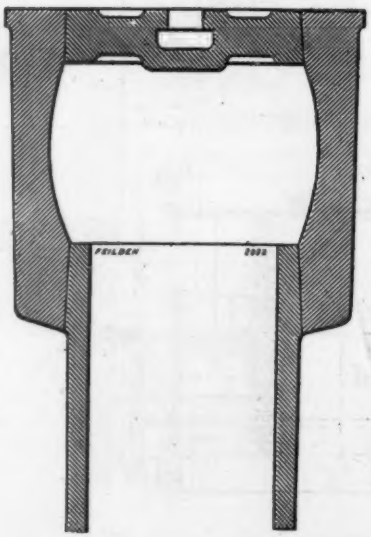
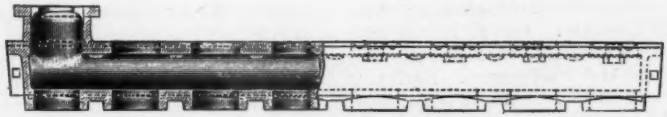


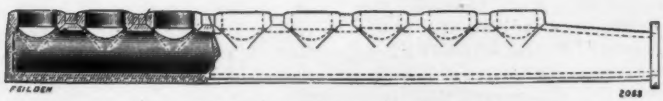
FIG. 20.—"INTERNAL" LID FOR TUBES OF ECONOMISERS.

A hopper terminating in a long sheet-iron pipe delivers fuel directly to the charging-box of each boiler. The conveyor itself comprises 200 buckets, each having a capacity of 1 cwt., and makes six complete cycles per hour. Thus 60 tons of coal can be dealt with per hour. An automatic filling apparatus is attached to the conveyor in the subway, so that each bucket may be automatically filled without any of the fuel being scattered upon the floor. In order that the conveyor chains may always be kept taut, a simple tension gear is provided. This consists essentially of a cast-iron frame, to which two semi-circular castings, resembling two halves of a wheel, are secured. These are spaced at such a distance apart that they form rails upon which the conveyor chains run as they pass from the forward to the backward track. The whole arrangement can be drawn in an outward direction by means of bolts attached to the end wall of the building. Motive force is furnished by a 8-h.-p. electric motor of the British Thomson-Houston C.E. type.

Ashes are raked from the ash-pits into waggons running on tracks laid close to the boiler foundations of each battery, as indicated in Figs. 17, 18, and 19. These



PART SECTION OF TOP BOX.



PART SECTION OF BOTTOM BOX.

FIG. 21.—TUBE BOXES OF ECONOMISERS.

tracks, laid in the central subway, which is 8 ft. high by 19 ft. wide, are of the ordinary railway gauge, and communicate directly with the siding from the West London Extension Railway.

Referring to the sketch-plan, Fig. 16, and the section, Fig. 19, it will be observed that the main flues, 10 ft. high by 8 ft. wide, pass beneath the outer gangways at the back of the boilers, and are then continued to the chimney shafts, having suitable by-passes in connection with the economisers. The chimneys are of red brick, lined with fire-brick about half-way up, 200 ft. in height, with an internal diameter of 10 ft. at the top. Four Green's economisers (*DD*, Fig. 16), of 384 tubes each, are installed in two chambers, one on either side of the main flue. The arrangement is such that any one of the economisers can be worked separately, so as to facilitate shutting down for cleaning or repairing. The economisers are built up of sections containing 96 tubes, the groups being coupled together at the top and bottom by expansion elbows, and fitted throughout with internal lids of the type shown in Fig. 20. This spacing arrangement permits free access to all parts of the apparatus. The aggregate heating surface is 15,360 sq. ft., and the water capacity is approximately 9,300 gals. It is quite unnecessary to refer to the advantages to be derived from the use of an economiser for the heating of feed water by means of waste furnace gases, but, so far as Green's economiser is concerned, the fact may be well mentioned that the apparatus has been applied to more than 200,000 steam boilers in different parts of the world, representing upwards of 30 millions i.h.p. All the tubes are of standard dimensions, being 9 ft. long by 4-9/16 ins. in diameter, and the sections are formed by forcing the tubes simultaneously into longitudinal top and bottom boxes by means of hydraulic pressure. Illustrations of the top and bottom boxes are given in Fig. 21. As the tube ends and the sockets are respectively turned and bored, a satisfactory metal-to-metal joint is secured. When in position, the sections are connected by longitudinal branch pipes, one at the top and the other at the bottom, the latter being provided with access holes and covers for the removal of sediment. In order to ensure equality of thickness and freedom from imperfections, the tubes are cast vertically, and each tube is tested to a pressure of 650 lbs. before leaving the works. Each tube is furnished with a set of Green's patent triple scrapers with chilled cutting edges; the scrapers rest upon lifting bars and are kept in position by guards. These travel with the scrapers slowly up and down the tubes for the purpose of preventing the accumulation of soot, which would very soon result in diminished efficiency. Suitable gearing for working the scrapers is fixed to the upper part of the economiser, outside the chamber, and the gear includes a simple

reversing motion with clutch box, lever, and rolling weight. Fig. 22 is a section through an economiser chamber, showing the scrapers, and scraper gear. Each pair of gears at Shepherd's Bush is actuated by a 5 h.p. direct-current electric motor.

Water for use in the Depôt is drawn from the system of the Grand Junction Waterworks Company, and before delivery to the storage tank behind the power-house it is treated by the Archbutt-Deeley softening process. The water supplied by the company has the average total hardness of 15 degs. "Clark," equivalent to 1 gr. of calcium carbonate per gallon; but as a matter of fact the unstable bi-carbonates constituting "temporary" hardness only amount to 12 grs., the remaining hardness, described as "permanent," being chiefly represented by sulphates. As our readers are probably aware, bicarbonates are decomposed and precipitated as insoluble carbonates during the process of boiling, whilst sulphates suffer no chemical alteration; but sulphate of lime, which is usually the chief ingredient of permanent hardness, is always deposited in the form of hard scale, the amount increasing as the temperature of the water rises above the ordinary boiling-point. As the water in its ordinary condition contains 12 grs. per gallon of carbonates, which must be precipitated in the act of boiling, it follows that the weight of scale resulting would be about 1·72 lbs. per 1,000 gallons. Similarly the weight of scale due to sulphate of lime would be 0·43 lb. per 1,000 gallons. Remembering the large consumption of water in the generating station, it will at once be seen that the quantity of scale per annum would be a very considerable item. Water-tube boilers and economisers suffer very much if used with hard water, and the adoption of efficient softening apparatus is extremely desirable for such plant.

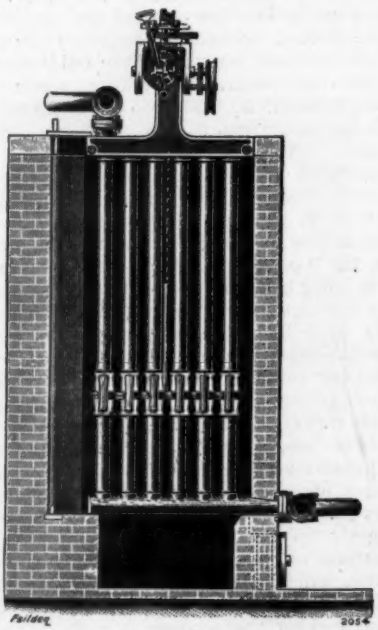


FIG 22.—CROSS SECTION THROUGH ECONOMISER CHAMBER.

The Archbutt-Deeley apparatus, made by Mather & Platt, Ltd., of Salford, was first applied at the Midland Railway Locomotive Works, Derby. After having been in operation for some time, the Locomotive Superintendent came to the conclusion that the process was not altogether satisfactory, as the ultimate deposition of minute floating particles proved to be detrimental to valves and other parts of the locomotives. This defect occurs in every other kind of softening apparatus, however carefully the effluent may be clarified, and we shall presently show in what manner it was successfully overcome by the patentees of the process now followed at Shepherd's Bush. As may be seen by inspection of Fig. 23, the apparatus consists of an ordinary cast-iron tank, over which a small corrugated iron building is placed. The tank measures 39 ft. long by 19 ft. 6 ins. wide by 10 ft. deep, and it has a wrought-iron division plate in the centre forming two compartments, each 19 ft. 6 ins. by 19 ft. 6 ins. by 10 ft. deep. Each compartment would actually hold about 24,000 gals., but its working capacity is about 20,000 gals., and as the compartments are worked alternately, the supply of softened water is continuous. One softening operation occupies about

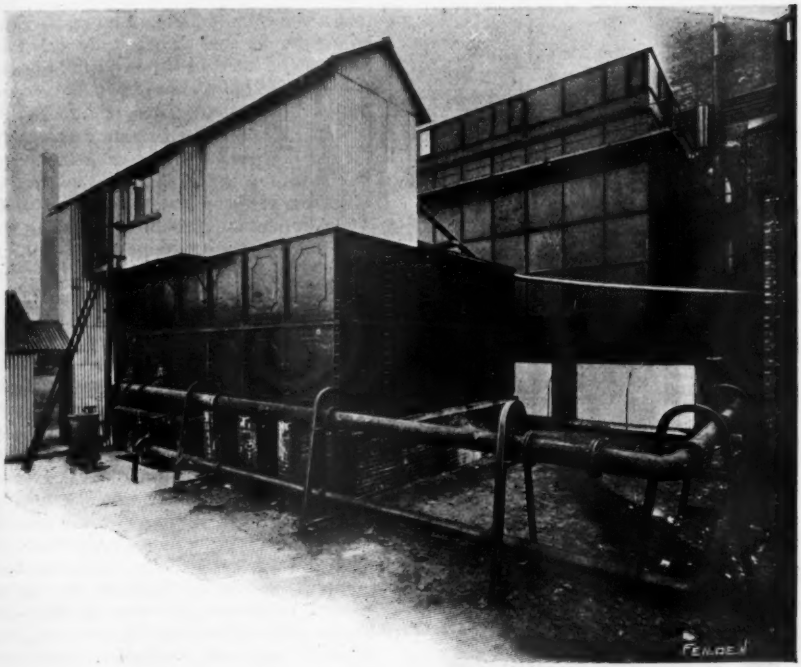


FIG. 23.—VIEW OF ARCHBUTT-DEELEY WATER SOFTENER AT C.L.R. GENERATING STATION, SHOWING BARNARD-WHEELER COOLING TOWERS IN THE BACKGROUND.

two hours, so that the average output of the plant is equal to 10,000 gals. per hour. The building above is the chemical house, where re-agents are weighed, mixed, and injected into the water. An interior view of this chamber is shown in Fig. 24.

The working capacity of the tank is rather more than three-quarters of its depth, as a certain quantity of water and old deposit is allowed to remain after the clarified water is drawn off. Water enters through the main service pipe, shown near the ground level in the illustration.

As the exact quantity of

FIG 24.—ARCHBUTT-DEELEY SOFTENING PROCESS: CHEMICAL HOUSE.

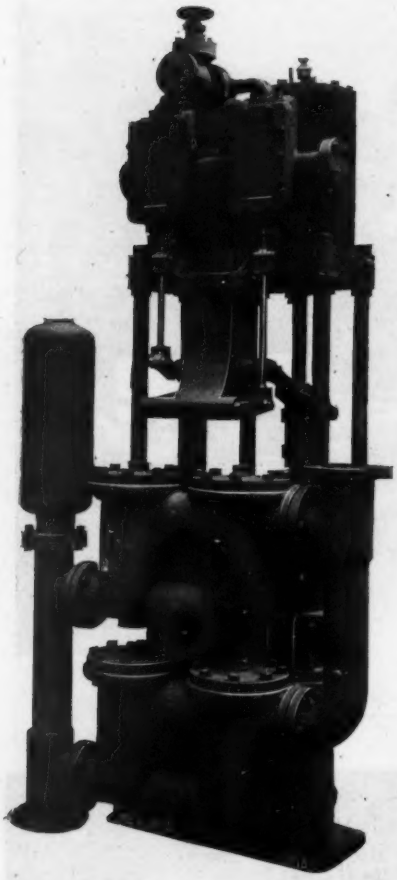


FIG. 25.—BOILER FEED PUMP BY F. PEARN AND CO., LTD.

water for treatment is always known, the proper weight of chemical can be mixed for every operation in one of the re-agent tanks to be seen at the right hand of Fig. 24, in connection with which there are various pipes, steam fittings, and a blower. After the lime has been thoroughly slaked, alkali is added, and the liquid is boiled until solution is completely effected. The reagent is then injected into the hard water tank through a series of perforated pipes, which are arranged in such a manner that a continuous circulation can be maintained by the aid of the blower. Thus the reagent solution is thoroughly diffused throughout the body of water to be softened. As soon as the water is thoroughly permeated with the reagent the old precipitate is blown upwards from the bottom of the tank, and it is mingled with the water in course of treatment. These operations, including rinsing out the chemical tank, occupy from 10 to 15 minutes, and in the course of about two hours the softened and clarified water is ready for drawing off. As the water leaves the tank it is submitted to the further process of "re-carbonation," which has the effect of dissolving any small floating particles remaining in the water. Carbonic acid for this purpose is generated in the small coke stove shown at the left-hand side of Fig. 23, and the gas is delivered by a small blower into the floating pipe through which the water is drawn off. The inside of this pipe is constructed so that the water descends in a series of small cascades, and it is therefore thoroughly exposed to the action of the gas. To every 20,000 gals. of water 28½ lbs. of lime, 9 lbs. of alkali, and 8 lbs. of alumina ferric are added. On delivery from the softening plant the hardness is reduced to about 3 degs., the temporary hardness being almost entirely removed, and the sulphate of lime being replaced by sulphate of soda, from which no scale results. It ought to be mentioned, however, that the boilers should occasionally be blown off, otherwise the continual addition of sulphate in the feed would render the water so dense that overheating might take place.

Feed-water can be drawn from the delivery pipe of the softener, or from jet condensers fitted to the main engines. A considerable proportion of the feed is taken from the latter source, so that it may be obtained at the highest available temperature. The water is then pumped through a series of Railton & Campbell's filters into the economisers. A by-pass main provides direct communication to the boilers from the feed pumps and filters, and thus the whole of the economisers may be shut off if required.

Two vertical duplex ram pumps, made

by F. Pearn & Co., Ltd., of Manchester, are used for boiler feeding purposes. These pumps, one of which is illustrated in Fig. 25, have Pearn's patent system of outside packing, 8-in. rams, and 12-in. steam cylinders with a 15-in. stroke. The duty of each pump is rather more than 16,000 gals. per hour, and there will be an ample reserve of power, even after the other four boilers have been provided. The feed-pumps are situated in a chamber set apart for auxiliary plant in the basement of the main power-house, where also the feed-water filters and a Wheeler surface condenser are placed. All the exhaust steam from the auxiliary engines passes through this condenser, which has about 1,900 sq. ft. of cooling surface, and is fixed immediately above the air and circulating pumps. Water supplied to the condensing plant is drawn from the storage tank previously mentioned, and after having been cooled it is discharged into the same tank, which is formed beneath the cooling towers (Fig. 26). Although constituting a departure from the strict sequence in which the plant of the Generating Station ought to be considered, it will perhaps be convenient that reference should be made at the present juncture to the cooling towers. There are four of these, as shown on the sketch-plan (Fig. 16), and two of them are also to be seen in Fig. 23, behind the Archbutt-Deeley water-softening apparatus. The range of towers stands about 10 ft. away from the north wall of the power-house. Each tower is 14 ft. 8½ ins. wide by 50 ft. high from the foundation to the summit, and about 40 ft. in height from the ground level. As will be seen by the photograph and by Fig. 26, the outer housing is chiefly built up of plates and angles, and at the lower portion a fan is provided. A similar fan is also applied at the back of the tower. All these fans are driven by single-cylinder engines of 35 h.p., by Belliss & Morcom, Ltd., of Birmingham. On entering the towers, the air-blast is suitably directed by means of baffle-plates, and in its passage upwards is met by hot water from the main and auxiliary engine condensers, which trickles from the top of the towers over screens of galvanised wire netting. On leaving the apparatus the condensed water is found to be reduced almost to normal temperature, and it is said that a very small proportion is lost by evaporation. We believe that this is the largest evaporative condensing plant at present installed in the country, and it will be interesting to learn at a later date what is the exact experience of the Central London Railway Company as to its efficiency.

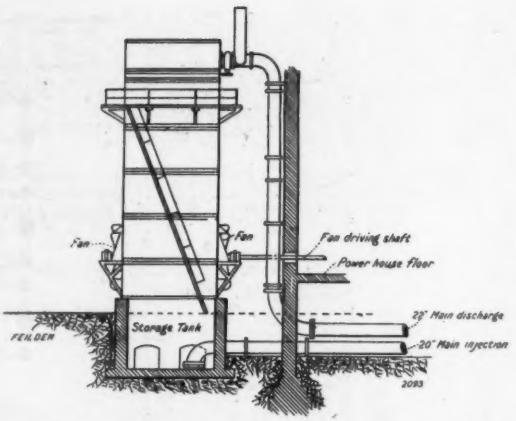


FIG. 26.—BARNARD-WHEELER COOLING TOWERS AT GENERATING STATION, SHEPHERD'S BUSH.

Before quite leaving the boiler department, we may usefully refer to the general arrangement of the main steam-pipes. Fig. 27 is a diagrammatic representation of the scheme, and it will be observed that each boiler or pair of boilers can be independently placed in communication with or shut off from the main steam-pipe; and that each pair of main engines in the adjoining power-house is supplied with steam by branches starting close to the feeding branches connected with each pair of boilers. Therefore it is possible

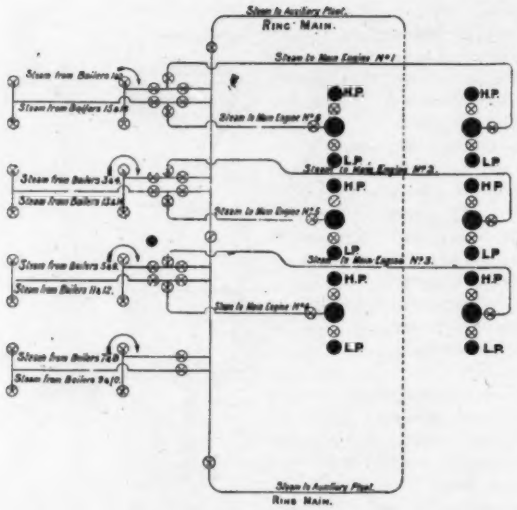
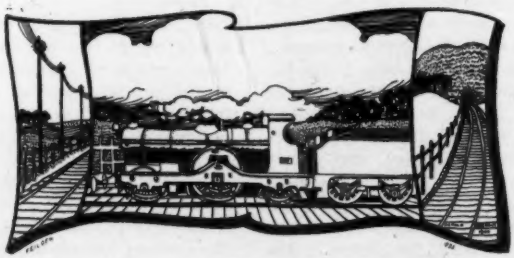


FIG. 27.—DIAGRAM OF MAIN STEAM PIPES.

to shut off any individual boiler, or any desired portion of the steam main without interrupting work, although, of course, if a section of the main were closed down, one or more of the engines would necessarily be stopped. As only four of the engines are required at one time for working the line, this contingency would cause no inconvenience. The steam-pipes enter the power-house beneath the floor level, and the main exhaust runs beneath the floor and emerges at the northern end of the building. When dealing with the engine-room, further reference will be made to other details connected with the steam services.

(*To be continued.*)

W. M. Worthington



MACHINERY, APPLIANCES AND PROCESSES.

"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

ELECTRICALLY-DRIVEN PRINTING MACHINES.

THE problem of the direct coupling of motors to printing and other machines is one that engineers, both in this country and America, have paid a good deal of attention.

In the majority of instances the motors are direct coupled to the machines to be driven, and so far as the actual drive is concerned the combination is in every way satisfactory, provided that the motors are liberally rated and designed for withstanding sudden shocks, to which the armature is always liable through transmission from the gearing.

When it comes, however, to the question of "pinching round" by power, special methods have to be adopted, as often adjustments as fine as $\frac{1}{4}$ in. are required.

It would, of course, be impossible to do this by starting up an ordinary high-speed motor from rest, owing to the impossibility of obtaining a sufficiently fine adjustment. There are existent, in America, three different ways of obtaining this result, which may be briefly summarised as follows :—

I. Direct gearing into the printing machine through a spur-wheel and pinion, when the motor is large enough to drive the machine when fully loaded. The shaft of the motor is prolonged on the side away from the press, and has a worm-wheel fitted on the extreme end. Gearing into this is a worm which is fitted on the armature spindle of a very much smaller motor, this being used for small movements of the press and for low speeds. The starting switch is so arranged that the first few contacts control the small motor, after which it is cut out and the large motor started up. This system, therefore, requires the use of two motors, and a motor starting-switch of special design.

II. The "Teaser" system consists of a small motor-driven dynamo used in addition to the main motor, which latter is direct-coupled to the printing machine.

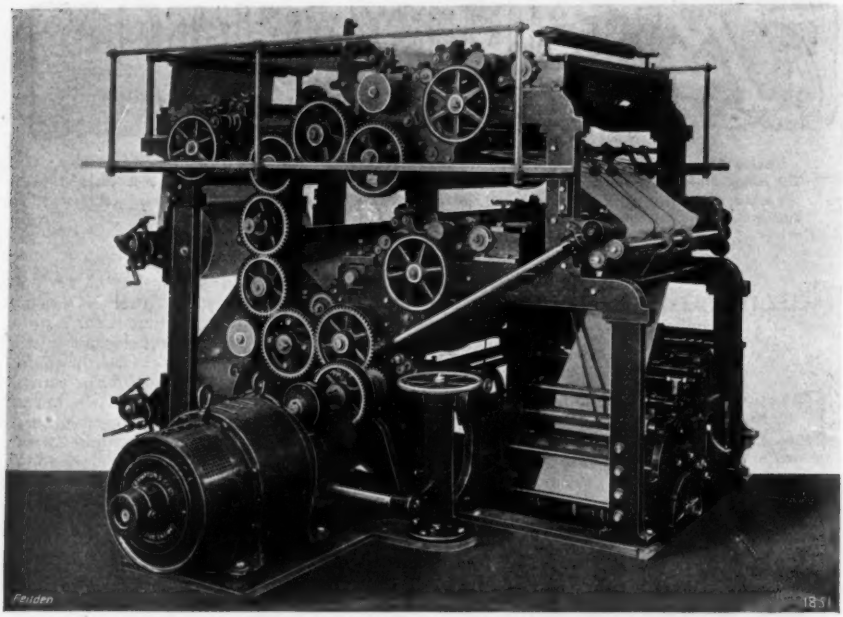
The motor end of this transformer takes its current at the same pressure as the main motor, whilst the dynamo part of the transformer gives current at a very much lower pressure. In this way, when lower speeds are required, the main motor is supplied with current at the lower voltage, whilst as soon as higher speeds are required the main motor is switched direct on to the higher voltage.

This system requires, therefore, three machines and a specially designed motor starting switch, which is arranged in such a way that the first few contacts supply the main motor with current at the lower pressure, after which the main motor is fed direct from the mains at the higher pressure. In addition to this switch, a separate motor-starter is used for controlling the motor of the transformer.

III. The third system is of a different character to either of the foregoing. Here only one motor is employed, and the variations in speed are obtained by means of shunting the series coils of the motor, and also by inserting resistance into the shunt field circuit.

Although these three methods give satisfactory results, and enable very fine adjustments to be made on the printing machine, and slow speeds to be obtained, yet it is at the expense of somewhat complicated methods and switches, which are expensive in first cost and liable to be expensive in maintenance.

The method of arriving at the same result, though very much simpler, is clearly shown in the accompanying photograph, and is due to Messrs. Crompton & Co., Ld., of Chelmsford, who designed the electrical gear, and to Mr. R. C. Annand, who designed the mechanical gear, as well as the printing machine, for the Northern Press and Engineering Company, Ld., of South Shields, the makers of the printing machine. In this the motor is started up light, and the load is



TWO-REEL WEB PRINTING AND FOLDING MACHINE, DRIVEN BY A DIRECT-COUPLED SHUNT-WOUND MOTOR.
MACHINE BY THE NORTHERN PRESS AND ENGINEERING CO., LTD., SOUTH SHIELDS.
MOTOR BY MESSRS. CROMPTON AND CO., LTD., LONDON AND CHELMSFORD.

gradually put on to the motor by means of a special friction drive, described below.

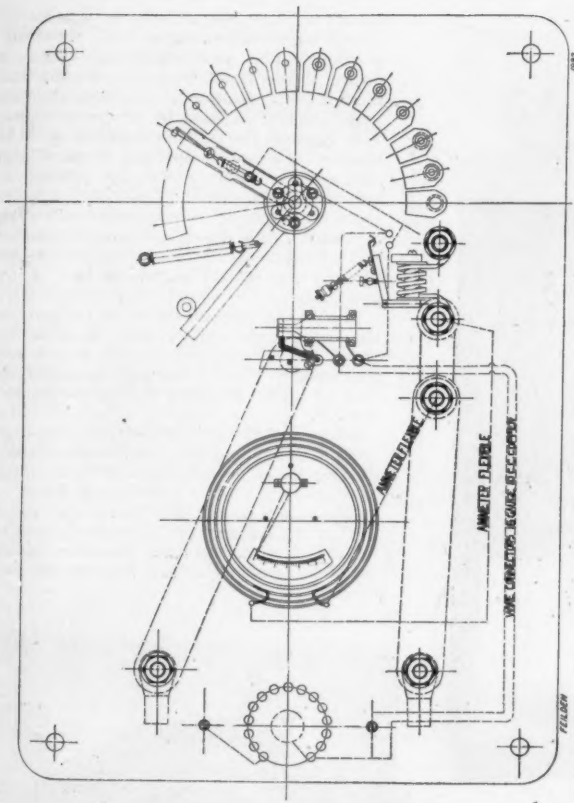
The photograph represents a two-reel web printing and folding machine, capable of producing four, six, and eight-page newspapers at the rate of 24,000 per hour.

Direct-coupled to this machine is a shunt-wound Crompton motor, designed to give 24 b.h.p. at 230 volt pressure when running at 850 r.p.m., which speed can be reduced to 600 r.p.m. by means of a regulating resistance in the shunt circuit.

The makers of this printing machine confine themselves solely to the manufacture of rotary web printing machines, in the design and construction of which they have attained a very high reputation. The speed at which these rotary printing nachines run, and the accuracy with which they must be constructed, require the most perfect system of manufacture, which only shops equipped with the most up-to-date tools can turn out.

As regards the gear itself, it will be apparent from the photograph that the movement of the hand-wheel on the top of the pillar, throws the internal member of the clutch inside the external member, thereby forming a driving connection. The external member is loose on the motor shaft, and has a small pinion at the back of it, gearing into the larger wheel upon the driving shaft. The internal member is movable lengthways on the shaft of the motor, but is driven at the same speed as the motor, by means of an internal driver, keyed on the motor axle, and sliding in a slot inside the driving member. One advantage is that, while the motor is running empty, there is no loose gearing being driven to make a noise. This connection between the motor and machine is simple and efficient, and occupies very little space. It might be mentioned in passing that, before a web machine of this description can be set running at full speed, a great deal of slipping must take place on the friction gear, and metal to metal contacts have been found, after prolonged experience, to be quite useless, in spite of the most careful lubrication.

This difficulty has eventually been got over by covering the inner cone with millboard



ELECTRICALLY-DRIVEN PRINTING MACHINES: STARTING GEAR FOR MOTOR.

about $\frac{1}{4}$ in. thick, which forms a splendid means of dry friction.

On the whole, this method of driving printing machines is a good deal simpler and cheaper than the usual methods described above, and, as equally satisfactory results are obtained, it is not surprising that the combination is meeting with considerable success.

The above figure shows diagrammatically the starting-gear for the motor. It consists of a multiple contact switch, which has been specially designed for the work with a maximum and minimum release. The object of the maximum release is to throw the motor out of circuit and save it from injury should the printing machine become jammed, and prevent an abnormal load being put upon it. The minimum release opens the circuit at the switch whenever the current becomes interrupted from any cause, and prevents the motor being suddenly started up when the supply is again resumed.

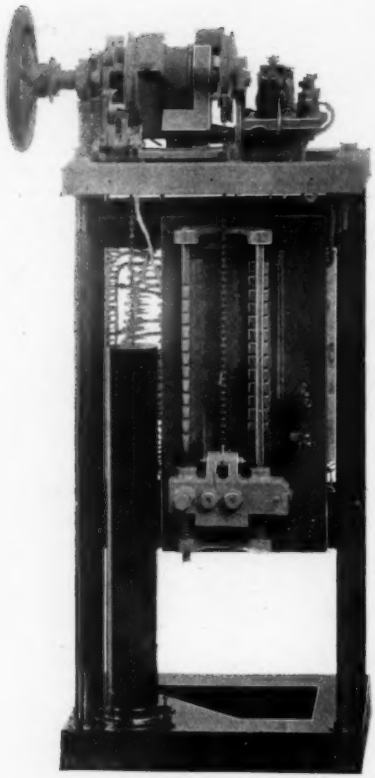
On the panel containing the switch is a current indicator, and at the bottom of the panel is a shunt-regulating switch, by means of which the speed regulation is obtained.

The slate switchboard is mounted in a cast-iron box with glass front, and at the back of the box are arranged the starting and regulating resistances.

NEW AUTOMATIC SWITCHES.

PARTICULARS have recently been the round of the electrical press of two new switches that were patented by Mr. Walter F. Jones two years ago, and are now being manufactured by the Electrical Transmission Co., Ltd., of Hammmersmith. Since, through the courtesy of the patentee, working drawings, not hitherto published, have been placed at our disposal, no excuse on our part is needed for issuing a further description of the apparatus.

The first, or, as it has been styled by the makers, the "B" type switch, is illustrated on page 700, the essentially novel feature of which is that the handle is not directly attached to the switch-arm, but is only held to it by electro-magnetic means when the conditions are suitable. The switch-arm and handle-lever are of iron, and have pole pieces attached to them, extending across the face of a coil mounted to surround the iron spindle of the switch; and together they constitute an electro-magnetic clutch. The switch also has a temporary contact (shown just above the clutch-coil in the illustration), a non-sparking arrangement (shown at the bottom left-hand corner of the illustration), and a maximum



AUTOMATIC "A" TYPE SWITCH.

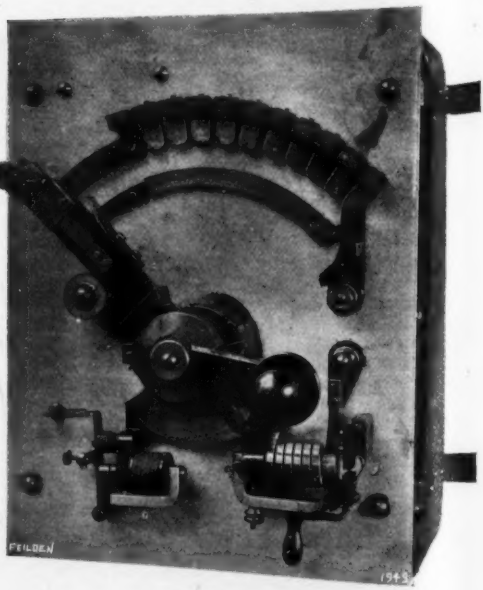
cut-out and hand switching-off handle (shown at the bottom right-hand corner of the photograph).

In the illustration the switch is in the "off" position, and the action of switching-on is briefly as follows: The handle is brought towards the switch-arm so as to bring the pole pieces together, and in doing so makes the circuit at the temporary contact, to energise the clutch-coil and also excite the motor magnets, as the clutch-coil is in series with the motor field-magnet coils. It is then necessary to pause for a short period, depending on the size of the motor, until the current in the field-magnets has risen to about its proper amount; as otherwise the clutch will not be sufficiently powerful for the switch-handle to draw the switch-arm against the spring which has brought it to the "off" position. The switch-arm may then be drawn slowly from contact to contact until the full "on" position is reached, when the switch-handle is held by a spring detent. The gradual rise of the current in the field-magnets of a motor, especially those of large size, can be easily noted by placing an ammeter in the circuit; and where it is not taken into account serious excessive flushing of current, with damage to switch contacts and sparking at the motor brushes, results, through the partial excitation only of the magnets.

Should the operator switch-on too fast, the maximum cut-out acts, short-circuiting the clutch coil, so releasing the switch-arm from the handle, when it springs back to the "off" position, inserting the resistances as it does so.

The object of the "non-sparking" arrangement is to temporarily close the circuit whilst the switch-arm is travelling to the first contact of the switch, when it is cut out of circuit.

The switch is provided with a wire guard, so that the action of the apparatus cannot be interfered with, and the maximum cut-out handle is arranged so that it cannot be held down.

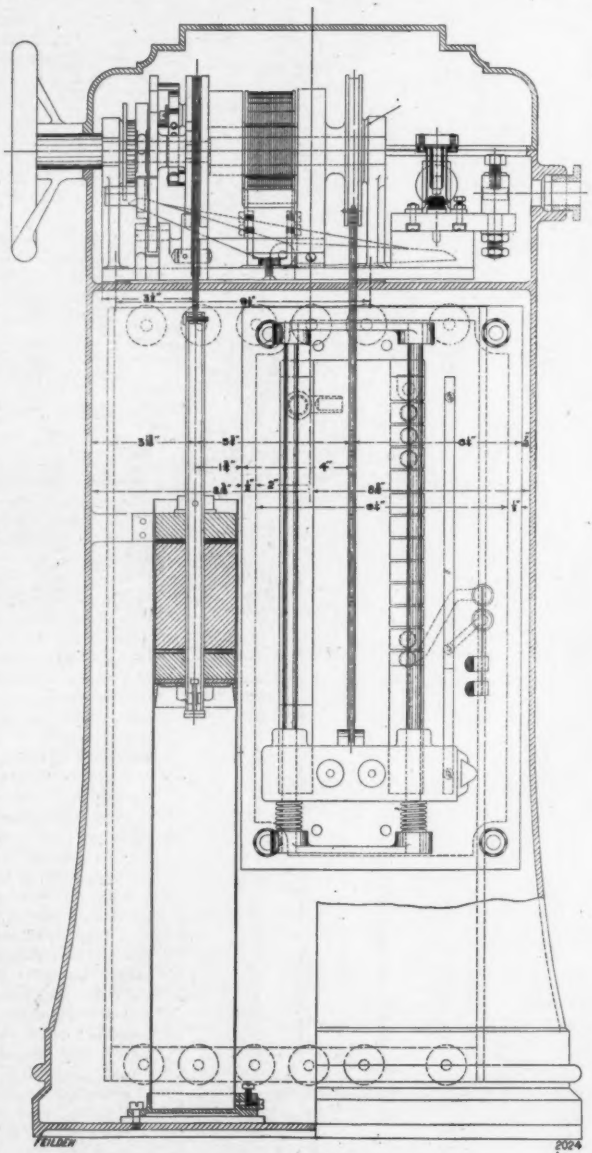


"B" TYPE SWITCH.

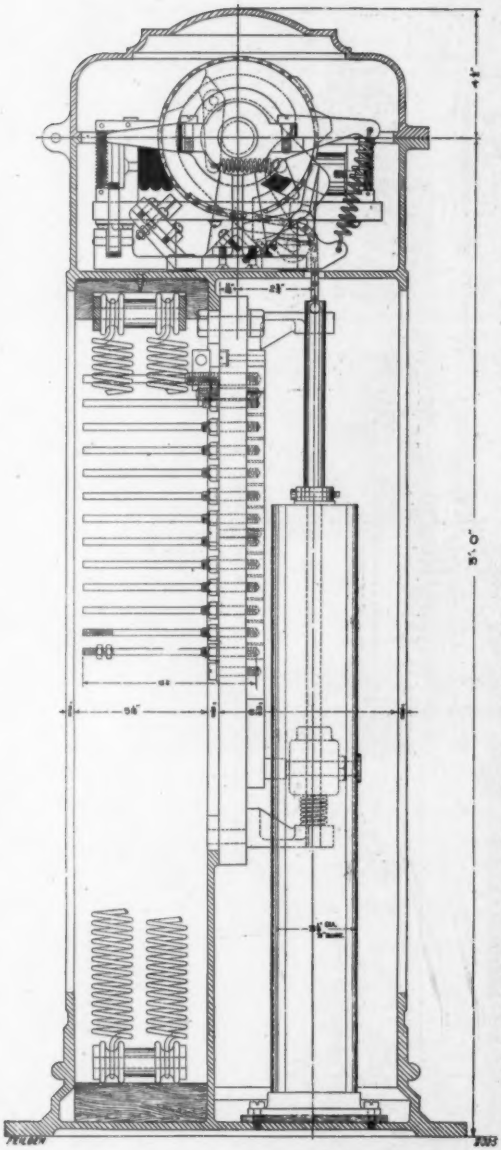
The apparatus possesses distinct features, in that it cannot be switched on until the motor field-magnets are well excited, or without a suitable difference of potential; and, moreover, if the operator attempt to switch on too quickly, or if the current exceeds a given amount or the supply fails, the apparatus automatically switches off.

The second or "A" type switch, illustrated at page 700, is, in general principle, the same as the apparatus just described; but the arrangement of the parts is different, the contacts being arranged vertically in alignment, and the clutch and other apparatus fixed at the top of the pedestal.

The great advantage attaching to this type of switch is that it takes the starting-up entirely out of the operator's control, and switches on at the speed for which it is adjusted. The operator is unable to interfere with the process of switching on, although at any time he can instantly switch off. It is thus practically impossible for the most unskilled operator to damage either the motor or the switch. It also avoids a fault which has prevented the satisfactory continuous working of other slow-moving switches, in that the switch-arm stops when fully on each contact and proceeds with a "quick-make" to the next, when cutting out the resistance switching on. This prevents the fusing and sparking which takes place with a slow-moving switch-arm, owing to the great current density when passing from one contact to the next; as practically the whole current passes through the contact in advance, and with a slow-moving switch the actual contact area for a considerable time may amount to little over a line or a point.



DETAILS OF AUTOMATIC "A" TYPE SWITCH.



DETAILS OF AUTOMATIC "A" TYPE SWITCH.

The above results are arrived at as follows:—When starting-up, the operator winds up a heavy weight in a dash-pot, by means of a spring-bolt. When fully wound up the hand-wheel shears out of engagement with the weight by compressing the spring-bolt, and is locked to prevent further forward movement. The weight then descends in the dash-pot, drawing the switch-arm over the contacts, and the "step-by-step" motion is secured by a spring detent which acts at each contact. The action of moving the hand-wheel backwards to switch-off causes the short-circuiting of the clutch and release of the switch-arm.

There is nothing outside the case (in the illustration, this, of course, has been removed) but the operating hand-wheel. The side doors are bolted from the inside of the top cover, which is fastened by means of a padlock.

OKES' PATENT SAFETY COVER.

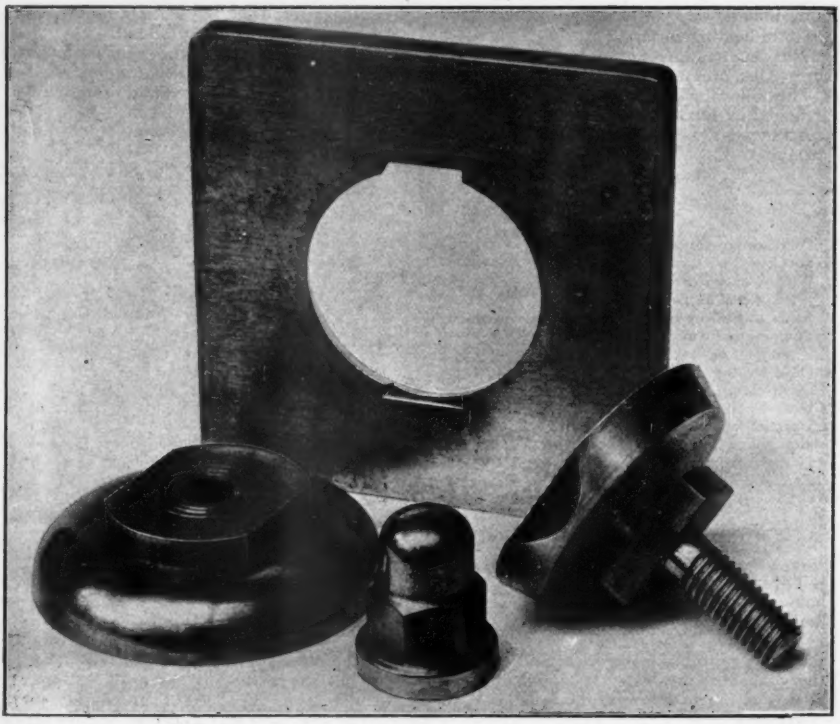
THE cover we illustrate has been designed to meet the requirements for a safe cover, more particularly in water-tube boilers, though it will be found useful for a variety of other purposes, such as for mud and hand holes in locomotive fire-boxes, &c.

In boilers, wherein water tubes form the essential part of the generating surface, the water tubes are usually passed through the front or the back plate of the headers—openings being necessary for obtaining access to the tubes. These openings being exposed to the internal pressure, require an absolutely safe cover—a cover wholly independent of the strength of the central bolt—especially for those in front, at which the stoker works.

For this, the cover illustrated is admirably suited, as it is coned from within and the internal pressure of the steam renders it tight, or practically so, should any accident to the central bolt occur, of which it is thus independent.

The problem of passing this valve into position from without is extremely simple and ingenious. It will be observed, by this illustration, that the tube plate is coned—the larger diameter being within the boiler, and that the smaller is in front, outside; in the smaller diameter two notches or flats are formed; also, on what may be termed the valve, two similar flats are cut, in each case only one half way through—hence, by bringing these two parts together, the "valve" may be passed edgeways through the opening in the boiler plate.

When the valve is put into position, by turning it one quarter round, the flats on the



OKES' PATENT SAFETY COVER.

valve, and the notches in the plate, will be at right angles to each other, and not coincide ; hence, the valve will form a joint which, though perhaps not absolutely tight, will prevent any dangerous rush of steam or water in case of of fracture of the bolt.

For the perfect joint, the outside cover is provided with a washer of leather, cloth, or other material.

The oblong lug on the central bolt performs three functions. First, it enables a wedge to be dropped over the bolt and hold the valve in position whilst the cover is being placed on ; secondly, it indicates whether the valve is in its proper position ; and, thirdly, by fitting in a recess in the cover, it prevents the whole turning round whilst the nut is being screwed up, as a spanner can be held upon it.

This Safety Cover appears to have been well considered, and worked out in a practical form.

SOME EXPERIMENTS WITH INDUCED v. NATURAL DRAUGHT.

THE object of these tests was to see the effect produced by working under the two conditions, as it is a well-known fact that with chimney draught, in windy weather, the draught is to an extent retarded. Also to see if an economy is produced by using the same coal as with the chimney, and if possible to use cheaper coal. This latter would be governed, whether or not the localities had collieries near. By experimenting with the different coals, the results were as below :—

The boilers were two in number (two Lancashire) 26 ft. 6 ins. long × 7 ft. dia., with a grate area each of 35 sq. ft., or a total heating surface of 1,616 sq. ft. and total grate area of 70 sq. ft. Working in conjunction with

both boilers was an economiser of 1,280 sq. ft. of heating surface.

The chimney was 120 ft. high, boiler pressure 58 lbs. pressure above the atmosphere.

The following gives the whole of the tests arranged in detail.

Arranged 1, 2, 3, 4.

	Chimney Draught.	Induced Draught.		
	1	2	3	4
Total water evaporated ... lbs.	60·720	67·500	66·700	66.100
Total coal consumed ... lbs.	7·392	8·064	8·176	11·080
Weight of water evaporated per lb. of coal as used	8·36	8·37	8·15	6·05
Ashes in lbs. during test ..	580	628	604	1397
Temperature of feed water to economiser	53°	34°	37·4° Faht :	38°
Ditto leaving ditto	252°	243·1°	253·1°	253°
Ditto entering economiser (gases)	729°	736°	798·4°	763°
Ditto leaving ditto	417°	419·7°	428·7°	416°
Duration of test ... ... hours	8	8	8	8
Draught of bridges	·2 inches	·35 inches	·35 inches	·35 inches
Draught at fan	——	2·25	2·25 inches	2·25
Cost of coal during test	£1 : 11 : 6	£1 : 7 : 4½	£1 : 14 : 2	16s. 8d.
Coal used	Best engine 9/6 per ton	Best engine 9/6 per ton	Slack 7/6 per ton	Slack 3/4 per ton
Cost of 1,000 galls. to evaporate	5s. 6½d.	4s. 0½d.	5s. 1½d.	2s. 6½d.

The weights of coal given is as used, having practically the same degree of moisture.

The whole of the tests were carefully made, by calibrating the water and weighing the coal, also the water level and thickness of fire at finish of trials, the same as at the commencement.

The sectional view shews the chimney, also the induced fan, the latter having a 21 ins. dia. inlet and outlet, with an iron chimney attached, about 34 ft. high.

The coal used in tests 1 and 2 were best engine at 9*s.* 6*d.* per ton. In test 3, slack at 7*s.* 6*d.* per ton from the same colliery; in test 4 was from a different colliery, and were about $\frac{5}{16}$-in. and $\frac{3}{8}$-in. cubes (screened).

In test 4 it is noticed the amount of ashes is greatly increased, due to the air spaces between the bars being full $\frac{3}{8}$ in. wide, which would allow of a quantity of coal to fall through, unconsumed.

(The air spaces were altered to $\frac{1}{4}$ in., which reduced this waste, but not tested to see result).

This latter coal was used for some time, but the difficulty is in getting a continual supply. The effect of reducing the air spaces between the bars does not reduce the draught, as compared with natural draught; the main damper can be closed to $\frac{1}{4}$ open. One distinct advantage over natural draught is, no matter what the state of the weather, the draught gauge is not altered.

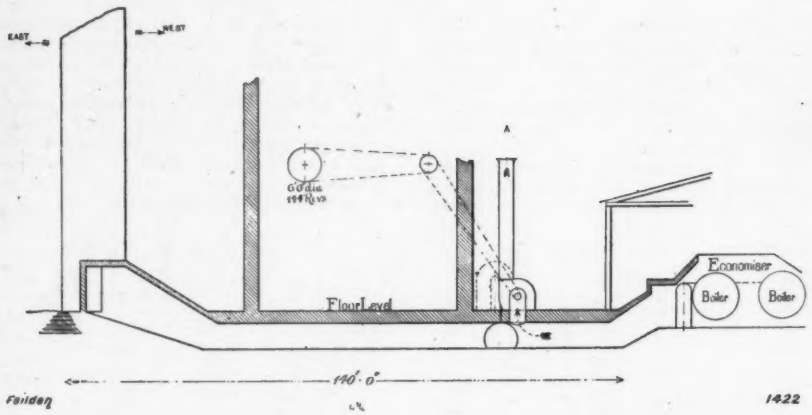
In this arrangement the induced fan was driven from the main shafting and was therefore at a fixed speed and draught, also rate of combustion.

It is usual when erecting plant with induced fans to have a stand-by, each driven by a separate engine, the consumption of steam used by the latter being about 4½ % of the steam generated, arranged thus; the consumption of coal per sq. ft. of grate can be decreased or increased by slowing or increasing the speed of fan engine.

The fan used was a 60-inch Sturtevant, at 750 revolutions per minute, to deal with the products of combustion of 1,000 lbs. of coal per hour.

The iron chimney erected on the fan outlet was to allow the smoke to go above the building; also after boiler cleaning on Sundays, having lighted the fires about midday, by 6 o'clock the next morning the pressure would be about 55 lbs. in the boilers, and as soon as the fan was started the blowing off limit 60 lbs. was soon reached.

The power to drive fan, as given, is 5 h.p. This class of installation is quite common in America, whereas in this country very little seems to have been done, favouring forced draughts. Whether it is due to our authorities requiring all stacks to be a certain height to suit local surroundings, or fear of smoke, is questionable, but the writer has noticed with the induced draught, which is more constant, the smoke question is tackled easier than with chimney, but the latter has the advantage of carrying it higher. The cost is given for evaporating 1,000 gallons. Comparing column 1 with chimney draught,



EXPERIMENTS WITH INDUCED *v.* NATURAL DRAUGHT.

and No. 2 induced draught, and the same quality coal, shows considerable saving, also the advantage is on the side of the induced fan, due to increased evaporation which is an important point sometimes. Even if there is an existing chimney, a fan of this description can be erected to give the same increased evaporation, by having a damper in the flue, the fan drawing it from the boiler side, and delivering into the chimney side.

Another very important point suggested by these results, is the reduced capital outlay where new works are being put down. The cost of chimney, 100 feet high say, £800; the approximate cost of a fan, as mentioned, with iron chimney, counter-shafts, fixed, not exceeding £120.

COMBINED WATER AND FLUE-TUBE BOILER.

(HALLETT AND HALLIDAY'S PATENT).

Now that a commission is sitting to consider the question of water-tube boilers in the Navy, the introduction of a new boiler which has the lightness of the water-tube boiler and also retains the many advantages of the flue-tube boiler is of some interest. This new type of boiler consists of interchangeable sections, each section being composed of water-tubes connected to headers at each end. The water-tubes are inclined downwards towards the back, and the headers are inclined slightly to the vertical. The water-tubes are expanded into the inner wall of the headers. Through each of the water-tubes there is placed a flue-tube, the centre line of the flue-tube coinciding with the centre line of the water-tube, and thus annular spaces are formed between the flue-tubes and the water-tubes. The headers are formed of dished plates with a flange all round, and the outer wall is a plate attached to this flange. The flue-tubes are jointed to the outer wall by being expanded to the back plate with a specially-designed joint, and to the front plate by a special nut joint.

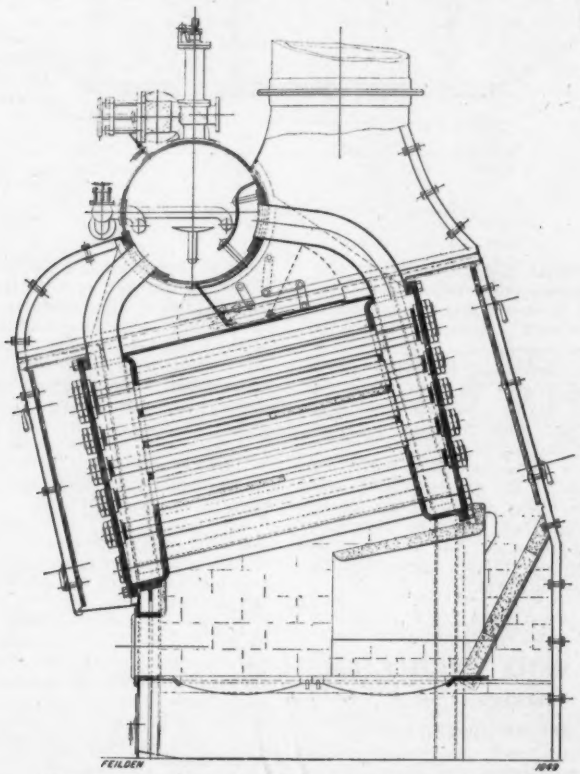
The headers are connected to the steam drum by means of pipes, while the drum itself is supported by saddle-plates or bearers attached with angle irons to the headers and steam drum.

The hot gases formed above the fire split up into two currents: one passes up amongst the water-tubes, while the other current goes over the bridge into the combustion chamber at the back; and then, through the flue-tubes to the smoke-box, both currents of the hot gases meet again in the uptake above the water drum.

The circulation of water is as follows:—When the water-tubes are heated the water in the annular spaces flows along to their higher ends and then rises up the front header to the steam drum, where it parts with the steam generated in the tubes or in the header. At the same time water from the steam drum descends the back header and takes the place of that which flows from the annular spaces to the front header. Steam is generated at the surfaces of the water-tubes of the flue-tubes, and at the

surfaces of the headers. The back surface of the back header will be very efficient in this respect. From experiments made with a small boiler it was demonstrated that the circulation of water is continuous in one direction only, no matter how the boiler may be heated or forced.

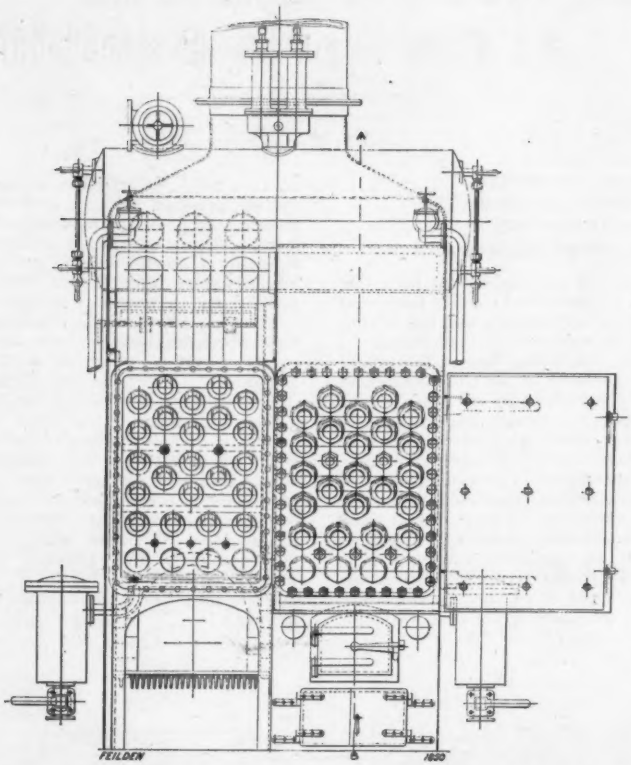
There is a damper for the outlet of the gases from the water-tubes, and another for the outlet of the gases from the front smoke-box. These dampers cover openings in the enclosing cover of the boiler, which is lined with non-conducting material to prevent the escape of heat by radiation. By closing the front damper the hot gases are caused to circulate only amongst the water-tubes, and by opening the damper over the front smoke-box and closing the damper over the water-tubes, the gases are caused to circulate only through the flue-tubes. Another method is to have a separate fire at the back of the boiler for supplying hot gases to the flue-tubes. There is a mud drum connected to the bottom of the back header. The feed-water is made to go through a specially constructed economiser placed in the uptake. The outside covering forms the walls of the smoke-boxes back and front. Baffle plates are placed over certain parts of the water-tubes, so as to guide the hot gases amongst the water-tubes.



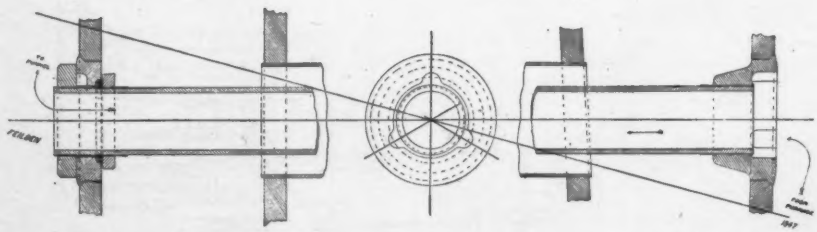
COMBINED WATER AND FLUE-TUBE BOILER: SECTIONAL SIDE ELEVATION.

One method of attachment of the flue-tubes is shown on the opposite page.

The advantages of this arrangement of boiler are, that it has the lightness of the water-tube boiler, and by the division of gases directly over the fire, the circulating water flowing through the annular spaces is heated with gases of the same temperature, and thus the heating surface is doubled for an extra weight of the flue-tubes alone.



COMBINED WATER AND FLUE-TUBE BOILER: FRONT ELEVATION, SHOWING ONE TUBE PLATE REMOVED.



COMBINED WATER AND FLUE-TUBE BOILER: METHOD OF ATTACHING FLUE TUBES.

Some Notable Exhibits at the Paris Exhibition.

(Continued from page 456.)

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ROBEY & CO., LTD., LINCOLN.
ERNEST SCOTT & MOUNTAIN, LTD., NEWCASTLE-ON-TYNE
COMBINED ENGINE AND GENERATOR.

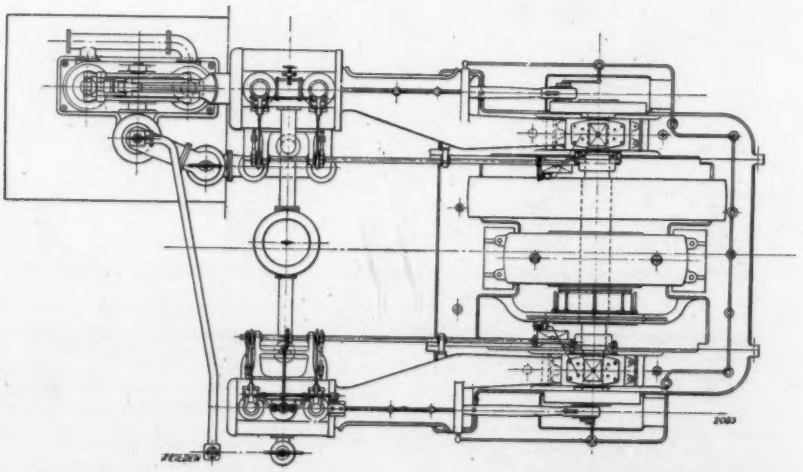
THE subject of our supplement plate this month is a combined coupled horizontal engine and generator, which was driving a section of the electric-light installation.

The engine, which is by Messrs. Robey and Co., Ltd., Lincoln, is of the cross-compound type, having cylinders 20 ins. and 35 ins. diameter by 42 ins. stroke, and designed to give 550 i.h.p. at its most economical load when running at 90 revolutions per minute. The main bearings are of massive construction and are carried on a base-plate, which also carries the generator. The engine is fitted with the "Richardson" Automatic Trip-gear, which gives an admission range of from 0 to ·75 of the stroke, according to the load, The flywheel is of very heavy section, and is designed to give only ½ per cent. variation. or 1 in 200. A condenser is fitted behind the low-pressure cylinder and fixed below ground, and is worked by means of a rocking lever. The air pumps are of ample size to maintain a good vacuum, and continuous lubrication is fitted to all working parts suitable for continuous running.

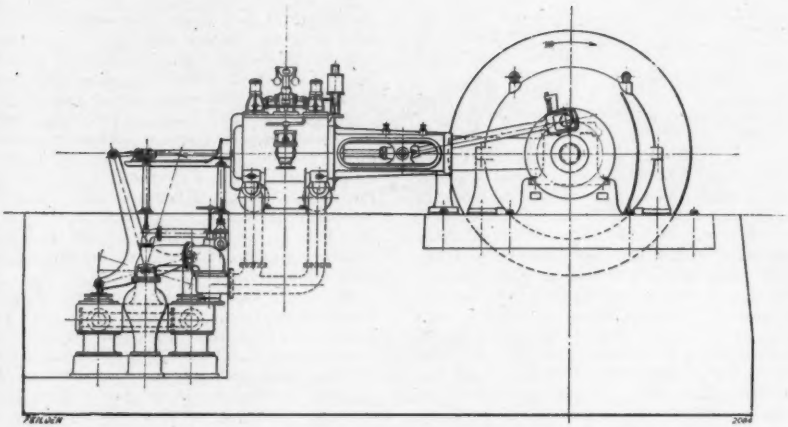
The generator is of the shunt-wound type, fitted with a drum-bar armature, and designed to give a continuous current of 350 kilo-watts at 250 volts. It is by Messrs. Ernest Scott & Mountain, Ltd., of Newcastle-on-Tyne.

The regulation of the e.m.f. is effected by means of "Richardson's" Electric Regulator, which controls the steam admission valves, and is so arranged that in the event of a "short" in the mains or total cessation of the current the electric regulator will stop the engine. The whole plant is practically self-contained, and requires inexpensive foundations.

Particulars of the dynamo are as follows :



PLAN OF COMPOUND CLASS ENGINE AND GENERATOR: ROBEY AND CO., LTD., AND ERNEST SCOTT AND MOUNTAIN, LTD.



ELEVATION OF COMPOUND CLASS ENGINE AND GENERATOR: ROBEY AND CO., LTD., AND ERNEST SCOTT AND MOUNTAIN, LTD.

Output of machine	331·2 kilo-watts.
Volts	230 to 250.
Ampères	1,440.
Approximate r.p.m.	90.
Diameter of armature	60 ins.
Length over iron	20 ,,
No. of ventilating slots	5, each ⅜ ins. wide.
Inside diameter of discs	37 ins.
Number of teeth	184.
Corrected magnetic density in teeth at load	125,000 lines sq. in.
Size of slots	2 ins. × 5 ins.
Length of end barrels	6 ins.
Number of conductors	736.
No. of conductors per slot	4.
Ditto commutator bars	368.
Diameter of commutator	42 ins.
Rubbing length	10 ,,
Wearing depth	1½ ,,
Average volts per commutator bar	5.
Size of conductors	·15 × ·8.
Area gap	380 sq. ins.
Magnetic density in gap at full load	58,000 lines, sq. in.
Length of gap	·4375 ins.
Bore of poles	60·874 ins.
Magnetic flux through armature	22 megalines per pole.
Magnetic flux through magnets	26·5 ,, ,,
Co-eff. of leakage	1·2.
Size of shunt-wire	·212 diameter.
Total resistance of bobbins	10 ohms.
Temperature rise	47 deg. Fahr.
Exciting watts	5,300.
Resistance of armature	·00425 ohms.
Volts loss due to C2R = 6·1 =	2·65 per cent. drop.
Brush lead drop	1·8 per cent.
Total internal volts	244 to 264.
Armature core density	78,500.
Magnet core density	102,000.
Magnet ring density	74,000.
Estimated commercial eff. of dynamo	94 per cent.

A. BORSIG, OF TEGEL, Nr. BERLIN.

A 2/4 COUPLED EXPRESS LOCOMOTIVE, WITH SPECIAL SUPERHEATING DEVICE (SYSTEM, WM. SCHMIDT).

THE locomotive here described agrees in its general construction with the standard of the Prussian State Railways Administration. The essential difference between it and the twin-engines of the express-type consists in the superheater built into the smoke-box, which, in this new type, is correspondingly enlarged for the purpose, in accordance with the patent of Mr. Wilhelm Schmidt, of Wilhelmshöhe, near Kassel, and in the use of piston slide-valves, instead of the ordinary kind, for the working of the highly superheated steam.

The high degree of superheating, an average of 300 degs. Cent., is obtained, in conformity with the idea of the inventor, by a portion of the hot combustion gases developed in the fire-box being directly led into the superheater through a fire-tube of 250 mm. diameter placed between the water-tubes in the lower portion of the walls.

The chief dimensions of the locomotive are as follows :—

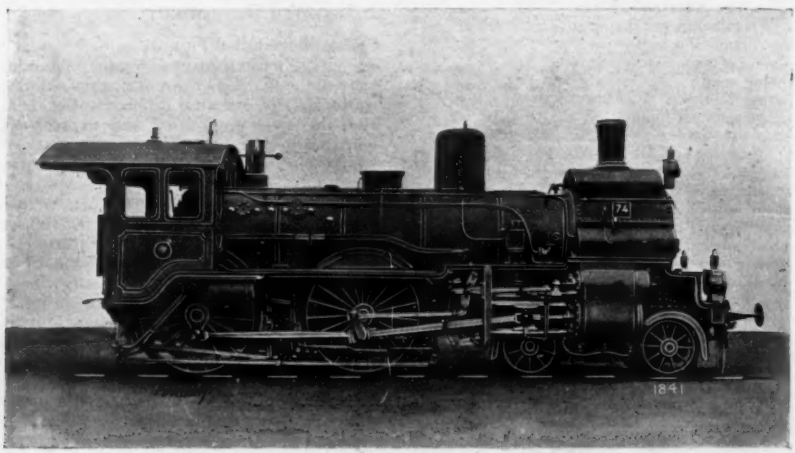
Cylinder diameter	500 mm.
Stroke	600 mm.
Driving wheels, diameter ...	1980 mm.
Wheelbase, rigid ...	2600 mm.
Wheelbase, total	7400 mm.
Heating surface, boiler ...	108·52 sq. m.
Grate area	2·27 sq. m.
Boiler pressure...	12 kg. per sq. c.m.
Weight in working order ...	31 tons.
Total weight	56 tons.

The super-heater consists of 60 tubes of 33 mm. diameter. These tubes are bent, in conformity with the wall of the smoke-box, in such a manner that every three of them form three practically concentric rings lying in the plane of a cross-section of the smoke-box, and the 20 groups of tubes thus formed are placed at short distances behind each other in the smoke-box. The 20 bundles of three tubes each formed by the upward-bent terminal of these groups of tubes are set into the floor of long steam boxes, of which there is one on either side of the chimney on top of the smoke-box. All of the 20 tubes of the inner rings are bent so that their lower portion forms an arch, and in this way a space is formed, enclosed by the thin arch and the two outer series of rings, into which the hot gases, after leaving the fore tube, directly enter. For details of the superheating device the accompanying diagrams may be consulted. It may be stated, however, that the hot gases, after leaving the arched space just described, encircle all the superheating tubes, flowing upward, and escape, together with heating gases from the boiler tubes, through the chimney. The fall of temperature of the heating gases from the moment that they enter a second admission tube until they escape through the chimney may be estimated from its effect to be 800 degs. Cent.; it suffices to raise the temperature of the wet steam, during a prolonged trip, from 192 degs. Cent. to 330 degs. Cent.

The new device does not add to the duties of the persons in charge of the locomotive. Even in exceptional circumstances, such as, for instance, the deficiency of a suitable lubricant, all that is required is to close certain lids in the superheater, and the locomotive continues to work as a twin-engine with wet steam.

Although, owing to the pressure of time, only one trial trip has been made with the locomotive here described before its despatch to the Paris Exhibition, it may be estimated on the basis of previous experiments with engines of the same, or similar, construction, that the efficiency of the boiler, without increasing its size, is increased 33 per cent. by the use of superheated steam of about 300 degs. Cent., which corresponds to an economy of fuel amounting to 25 per cent., as compared with similar twin-engines worked with wet steam, and to a very considerable economy in the use of water, which must also amount to 33 per cent. Aside, however, from a direct and considerable economy of fuel, this new type of locomotive promises to secure the following important advantages in the construction, running and maintenance of engines:—

1. The possibility of a return to the twin-engine, which, with suitable cylinder and



A. BORSIG: COUPLED EXPRESS LOCOMOTIVE (W. SCHMIDT'S SYSTEM).

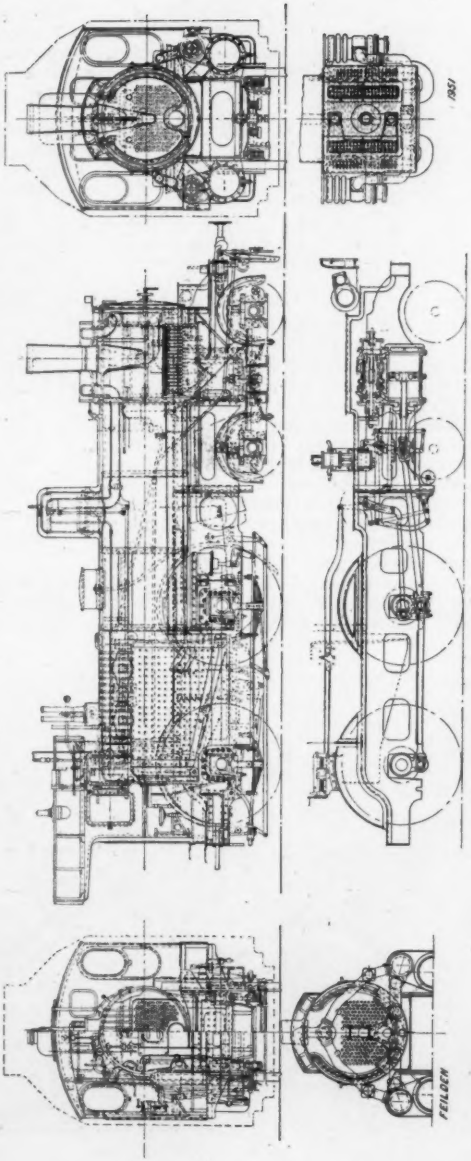
gear arrangement, is more simple and more economical than the four-cylinder compound engine.

2. The possibility of a return to steam tensions of 12—10kg., which means an increase in the length of life of a boiler, as compared with injurious effects of the high tension of 15 atm. and more at present prevailing.

3. The possibility of the maintenance of the sizes and weights at present in use, notwithstanding an increase of 33 per cent. in efficiency, which will suffice for any increase in traffic that may be anticipated in the near future.

4. Abolition of the dead weight of the tender, or, in case its present size is to be maintained, the possibility of running for a longer distance than hitherto without taking in a fresh supply of water.

5. Considerably less wear of the gearing apparatus in consequence of the arrangement of the piston-valves on both cylinders and the smoother running of the twin-engine.



DETAILS OF COUPLED EXPRESS ENGINE (W. SCHMIDT'S SYSTEM): A. BORSIG.

MESSRS. SULZER BROS., OF WINTERTHUR (SWITZERLAND) AND LUDWIGSHAFEN o/R. (GERMANY).

THERE can be no doubt that among the many fine exhibits for the supply of electrical energy at the Paris Exhibition those of Messrs. Sulzer Bros., of Winterthur, are among the most attractive and the most interesting, and do great credit to this enterprising engineering firm, whose well-known horizontal stationary engines, fitted with the patented drop valve, for many years were the most economical in existence as regards steam consumption, and are recognised to be not only highly efficient, but of superior workmanship.

To describe the whole exhibit of Messrs. Sulzer Bros. would require far more space than we can spare. We will select, however, two or three objects of a fairly typical nature, from which the reader may form a tolerably correct idea of the general character of this noteworthy display.

As regards the steam engines shown by Messrs. Sulzer Bros.,

the two largest exhibited by them deserve a somewhat detailed reference. The first of these, shown in the photograph below, is a four-cylinder triple-expansion engine, driving a fly-wheel dynamo built by Messrs. Brown, Boveri Co., of Baden, in Switzerland.

The following are the chief dimensions :—

High-pressure cylinder diameter ...	600 mm.
Intermediate-pressure cylinder diameter	850 mm.
Low-pressure cylinders diameter (each)	1025 mm.
Stroke	1500 mm.
Revolutions per minute	85

Load at an initial pressure of 11 atm. :

Normal load at 30% cut-off in high-pressure cylinder	1700 i.h.p.
Do. do. do. ...	1500 e.h.p.
Maximum load at 40 % cut-off in high-pressure cylinder	1950 i.h.p.
Do. do. do. ...	1750 e.h.p.

As shown in the photograph, the governor regulating the steam supply varies the point of cut-off through the intermediary of Messrs. Sulzer's normal trip gear. The valves of the high-pressure cylinder are automatically controlled by the governor ; the other cylinders have fixed points of cut-off, but the valves can be adjusted by hand so as to vary the point of cut-off between given limits. The type of the valves is that of the double-beat, and they fit closely down to the cylinder barrel, permitting only of the minimum amount of clearance. This style of construction is well fitted for a great number of revolutions and for large-sized engines, and Messrs. Sulzer have successfully employed these valves in many cases, as, for instance, in the vertical engines of 3,000—4,000 h.p. built by them for the Berlin Electricity Works, and also in the horizontal engines of equal h.p. built for the same works, as well as elsewhere. The valves are very tight fitting, and can be put in place without difficulty. The engine here described has two low-pressure cylinders, and an air-pump is driven from each crank situated below the engine-shaft. The use of two low-pressure cylinders, instead of one, permits of a very favourable distribution of power between the two cranks, and secures great uniformity in the running.

The second engine, exhibited by Messrs. Sulzer Bros., shown in the illustration on next page, is a two-cylinder tandem compound type with similar valves, and is used for driving a fly-wheel dynamo, manufactured by Messrs. J. J. Rieter & Co., of Winterthur.

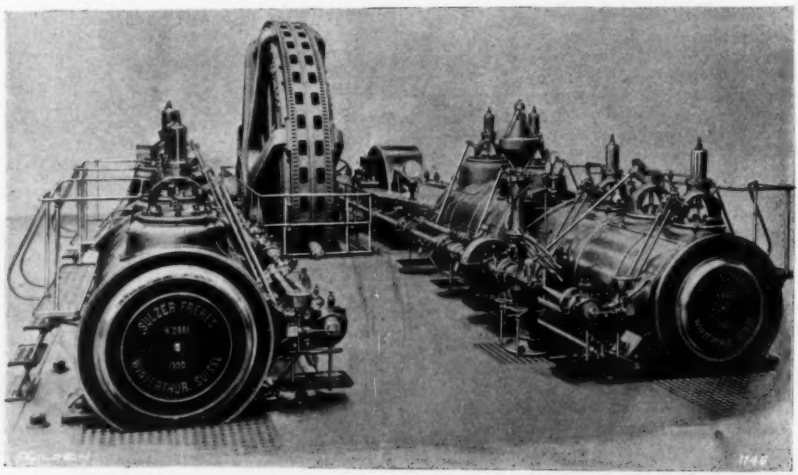
Its chief dimensions are the following :—

High-pressure cylinder diameter ...	525 mm.
Low " " " ...	875 mm.
Stroke	1100 mm.
Revolutions per minute	100

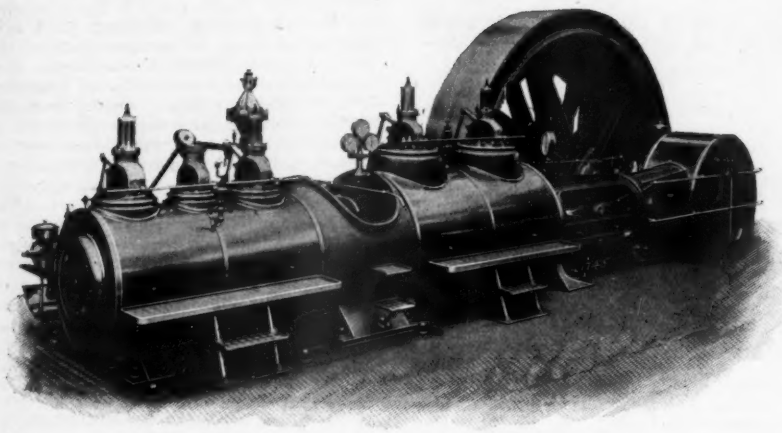
Loads at an initial pressure of 11 atm. :—

Normal load at 23 % cut off	750 i.h.p.
" " " "	650 e.h.p.
Maximum load at 40 % cut off ...	1000 i.h.p.
" " " "	900 e.h.p.

Though, as above stated, the valves are similar to those of the previously described engine, the operating gear is different and



FOUR-CYLINDER TRIPLE-EXPANSION ENGINE DRIVING A DYNAMO : SULZER BROS.



TANDEM COMPOUND ENGINE DRIVING A FLY-WHEEL DYNAMO: SULZER BROS.

represents a novel system described in German Empire Patents, No. 113311. This system takes into consideration the fact that engines for driving dynamos have to work frequently for long intervals of time with a small load, *i.e.*, with very small cut-offs in the high-pressure cylinder. In the new gear, the levers which lift the valves are made to roll upon a slightly curved adjustable race. The further end of the lever is connected with the valve-releasing mechanism, which differs from that in the four-cylinder engine on account of its special arrangement, though the governor varies the point of cut-off through it in a manner analogous to that of the normal trip gear. The leverage which is used at the beginning of the opening of the valve is great, but owing to the point of contact between the lever and the race shifting it is quickly reduced, and the latter portion of the opening is very rapid. For the closing of the valve a spiral spring presses upon the outer end of the spindle and returns it rapidly to its place after its release by the gear. The air buffer is placed in the rod connecting the outer end of the rolling lever and the releasing mechanism, where there is also an auxiliary spring for the closing of the mechanism. In a state of rest the lever is completely lifted off its race. When the mechanism is put into motion, it has at first a kind of empty run during which the air piston, even before the inlet valve is beginning to be raised, draws in by suction the required air. The opening of the inlet valve does not take place until later, *i.e.*, at the moment when the rolling lever with its inner end touches the curved race. As a great leverage, as above stated, is used to begin the opening, it is possible to obtain even the smallest valve-lifts, so that even at the smallest loads a very uniform cut-off and a faultless regulation is secured. The closing of the valve, after release, does not so much depend upon the air buffer as rather upon the law regulating the rolling of the levers in connection with the spiral springs and the rods. The brake-effect of the air piston, in fact, does not come into play until *after* the closing of the valve, in order to absorb the motion during the empty run of the rods and levers. This reduces the resistance to be overcome by the governor to a minimum, and consequently the engine runs evenly in all cases, and with all loads.

The outlet valves are regulated from the same eccentrics that regulate the inlet valves, and also by means of rolling levers. The regulation of the low-pressure cylinder is analogous, inlet and outlet valves being acted upon by one eccentric with rolling levers each, in such a manner that the cut-off and pressure can be varied between the necessary limits.

Besides the two engines above described, Messrs. Sulzer Bros. exhibit a twin-cylinder compound two-crank engine, with a central rotating distributing valve, and a vertical one-cylinder engine, with a normal power of 350 and 30 e.h.p. respectively.

Behind the tandem engine in the Paris exhibit were to be seen specimens of pressure and screw-ventilating fans, of which this firm manufactures a considerable number, and also various centrifugal pumps.

The following are the main data with references to sizes and capacities of these exhibits :

VENTILATORS.

	Delivery per minute in cubic metres	Pressure head mm. of water.	Revolutions per minute.
Screw Ventilator.			
No. o.	10	10	2,500
No. VI.	800	20	700
Centrifugal Pressure Ventilator.			
No. I.	4	50	3,500
No. IX.	200	600	1,500

CENTRIFUGAL PUMPS.

	Delivery per minute in litres.	Pressure head in metres of water.	Revolutions per minute.
Low-pressure Centrifugal Pumps.			
No. oo.	100	12	2,700
No. o.	300	15	2,800
No. V.	4,500	20	900
No. IX.	50,000	20	290
High-pressure Centrifugal Pumps.			
No. VI.	7,000	65	900

The high-pressure centrifugal pump here referred to is of the compound type and direct coupled, with an electro-motor. It is intended for the water-works at Frankfort o/M. (Goldstein - Plant), where there are already three similar pumps constructed by the same firm. Among the other exhibits of Messrs. Sulzer Bros. may be mentioned a collection of radiators and heating apparatus in Group VI. and in another part of the Exhibition, together with the Simplon Tunnel exhibit, specimens of their rock-drills of the Brandt type, which are shown in our photograph below.

R. WOLF, MAGDEBURG-BUCKAU.
STEAM-ENGINE.

THE exhibits of this firm comprise a semi-portable compound condensing engine, with a nominal capacity of 200 h.p. ; a portable high-pressure engine, with a simple variable valve gear and automatic regulator, with a nominal capacity of 12 h.p., and a maximum capacity of 24 h.p.

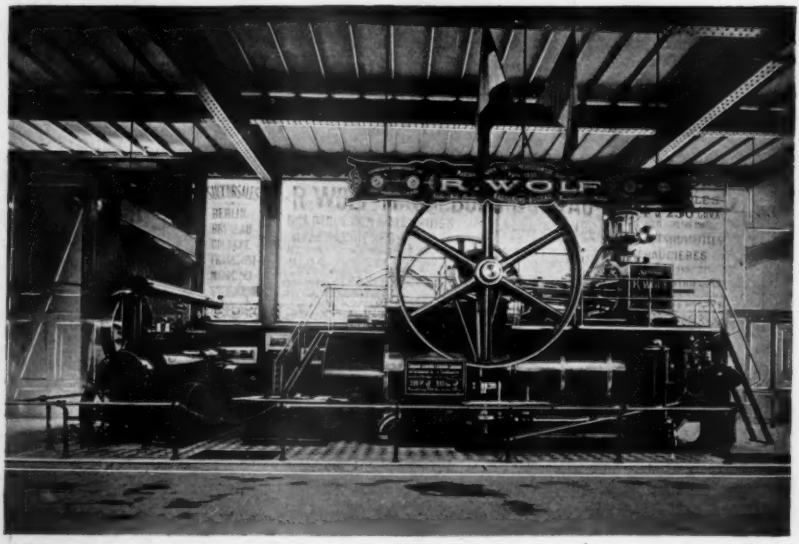
The semi-portable compound condensing engine is constructed on the compound

BRANDT TYPE ROCK DRILLS, AS USED IN DRIVING THE SIMPLON TUNNEL : SULZER BROS.

system, and it may here be remarked that the firm of Mr. R. Wolf was the first in Germany to adopt the system in connection with semi-portable engines. The high-pressure cylinder is fitted with the exact working "Rider" automatic valve-gear, which ensures not only a very profitable distribution of steam but great uniformity in running. This gear is controlled by a heavy, quick and exact working "Porter" regulator which is driven from the crank-shaft by means of a couple of noiseless moving cog-wheels. The low-pressure cylinder has simple variable valve-gear for regulation by hand. The vacuum produced by the simple working air-pump, which is driven by an eccentric, amounts from 85 to 90 per cent. The air-pump eccentric actuates at the same time the boiler feed-pump. A second feed apparatus serves as an injector. The machine when in normal operation produces 87 per cent. of useful work, although a maximum of 92 per cent. has been attained for a short period.

The boiler, which is on the removable tubular system, is constructed for a working pressure of 150 lbs. The engine in operation at the Exposition made 110 revolutions per minute, steam, however, being furnished by the Exhibition authorities, owing to the stringent regulations governing the firing of boilers. The following data show the efficiency obtained: With the undermentioned cut-off in the high-pressure cylinder, 0·2, 0·3, 0·4, 0·5, 0·55, and 0·48, 0·51, 0·53, 0·55, 0·6 in the low-pressure cylinder, the h.p. worked out as follows: 215, 265, 295, 330, and 360, the consumption of fuel being 0·7 klgs. to 0·8 klgs. per hour and eff. h.p., the heating value of the fuel being represented by 7,500 calorics.

The Portable High-pressure Engine is designed principally for agricultural purposes, and the chief aim in construction has been to combine the utmost simplicity with a ready accessibility of all parts. The gear consists of a three-port slide-valve, operated by an eccentric from the counter-shaft. The eccentric is so arranged that the eccentricity and lead angle can be set by adjusting the eccentric sheave on a set disc. It is claimed that it is thus possible to regulate the grade of expansion, according to the power required, so exactly—the expansive power of the steam being used to its full capacity—that these engines consume very little steam in excess of those fitted with automatic valve-gear. Variations in the load are quickly and precisely regulated by a special regulator driven from the crank-shaft by means of cogwheels, which, in turn, actuate the throttle-valve.



GROUP OF ENGINES: R. WOLF.

To lessen the danger from flying sparks these engines are fitted with a very simple, at the same time very effective, spark-catcher. The exhaust steam is utilised for feed-water heating purposes.

The boiler, which is on the removable tubular system, is designed for 150 lbs. pressure, and at 145 revolutions the normal capacity of the engine is 15 h.p., a maximum of 24 h.p. being, however, possible. The fuel consumption is 1·8 klgs. per hour and eff. h.p., with coal of 7,500 calorics heating value.

The cylinders of Wolf's engines are placed within the steam-dome, and constantly surrounded by fresh steam, the tendency thereby being to reduce loss of steam by condensation. The crank-shaft bearings are fastened to a strong saddle, which is riveted to the boiler case. A very strong support is thus afforded to the crank-shaft, the stability gained being probably greater than that afforded by means of supports adjusted between the steam-dome and the crank-shaft bearings.

In the construction of the engines as a whole many improvements of modern introduction have found recognition, which, taking into consideration the comparatively low consumption of steam and coal, render these engines capable of meeting very exacting requirements.

GEO. RICHARDS & CO., LTD., BROADHEATH. TURRET-HEAD BORING AND TURNING MILL.

THIS type of machine has attained to considerable prominence of late years; American firms have been making it a leading speciality for some little time, and our own makers are also well to the fore. The many advantages which these mills possess over an ordinary lathe are well known and appreciated by all who use them, as, besides offering easy facilities for chucking, the table on which the work rests is supported by the bed at its perimeter as well as at its centre. Again, the range of work which these machines will perform is very wide, and much that was previously done on the lathe or horizontal boring machine is now done on these mills, the saving effected being very considerable. They are now built in a number of sizes ranging from 24 ins. to 30 ft. diameter, and in a large-sized machine as much as 2 cwt. of metal per hour has been removed in the process of turning.

A British firm who has devoted much attention to this class of tool is George Richards & Co., Ltd., of Broadheath, Manchester, and a number of their leading specialities, including (1) a side planing machine; (2) a radial drill; (3) a slot drilling and keyway cutting machine; (4) a universal facing and boring machine; and

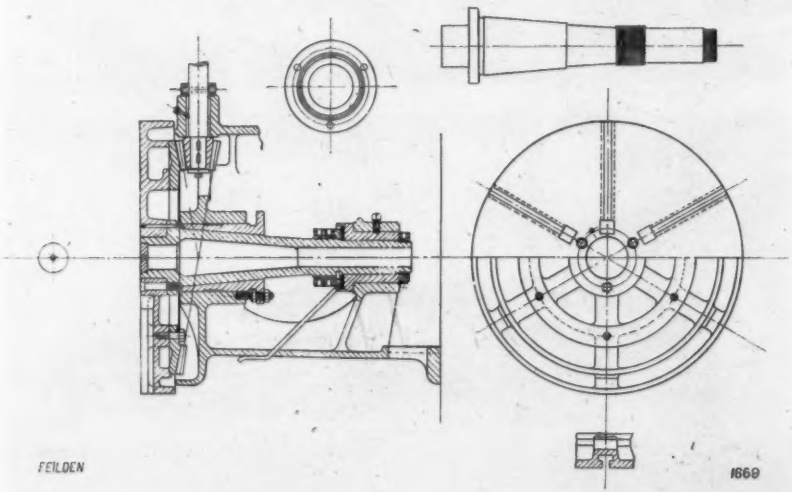
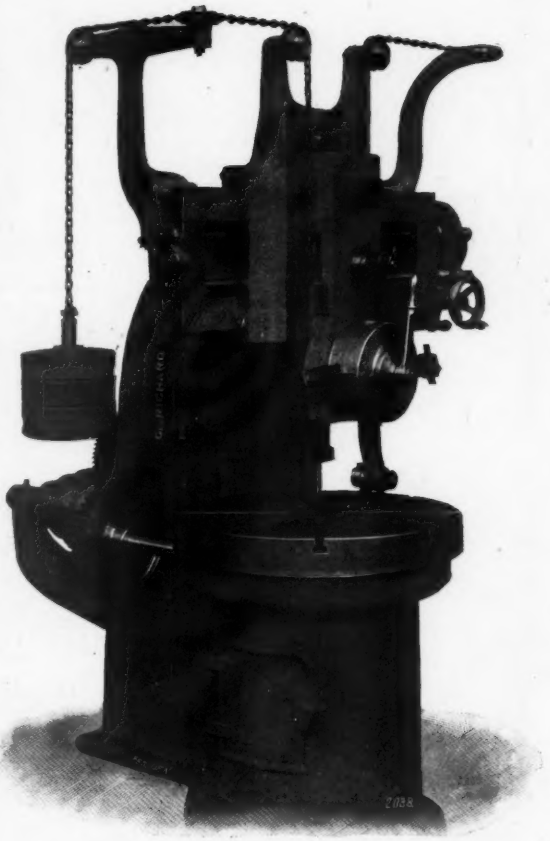


FIG. 1.—TURRET-HEAD BORING MILL.—PLAN AND SECTION OF REVOLVING TABLE: GEO. RICHARDS AND CO., LTD.

(5) a turret-head boring and turning machine, were on view at the Paris Exhibition. A general view of the last-named machine is shown by the accompanying half-tone block, whilst various other illustrations show the details of construction of the several parts. This particular machine is capable of boring and turning pieces up to 32 ins. diameter by 11 ins. deep. The main standard which carries the cross slide and turret-head is placed at one side of the centre of the table, so as to reduce the overhang of the tool, and to permit of the thrust of the cut coming more in the centre when the machine is turning at its largest diameter. The machine is driven by a four-speed cone-pulley with a 3-in. belt and double gear which drives the table through bevel wheels, and gives a total gear power of 50 to 1. The turret-head is arranged to receive four tools, whilst the slide upon which it is mounted has automatic cross and down feeds in either direction by means of worm and wheel, and friction discs arranged to give a feed from zero to $\frac{1}{4}$ per revolution of the table. Either feed can be disengaged by a clutch at the end of the cross slide.



TURRET-HEAD BORING AND TURNING MILL: GEO. RICHARDS AND CO., LTD.

The turret slide has a quick hand adjustment for taking out the bar in order to examine the work. The table is 28 ins. in diameter, and the distance from the table to the underside of the standard is 16 ins. The turret head slide is counter balanced, and has a down feed of 24 ins.

Referring to the various detail views, Fig. 1 shows in section and plan the revolving table with its spindle; also the bevel gearing which drives it. The spindle is also shown separately.

Fig. 2 shows details of the feed motion of the cross and turret slides and reversing gear.

Fig. 3 shows details of the friction disc arrangement for driving the above feed motions.

Fig. 4 shows the turret, arranged for four tools, the turret slide and balance gear.

We understand that Messrs. Richards were allotted less space than they applied for in Paris, but they fortunately succeeded in showing a fairly representative exhibit, their machines being in operation, and worked by a 15 B.H.P. electric motor of Manchester make. We congratulate this firm in the enterprise they have shown.

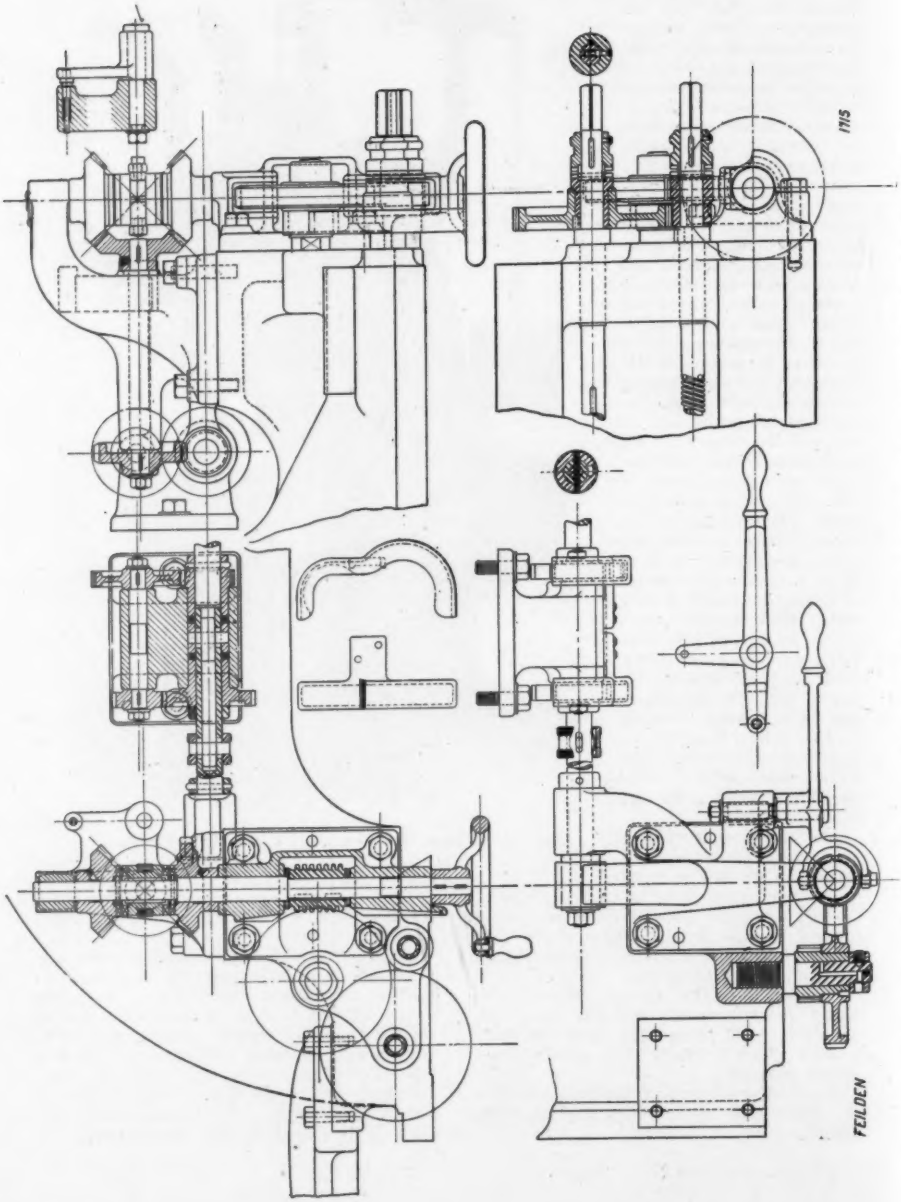


FIG. 2.—TURRET-HEAD BORING MILL.—DETAILS OF THE FEED MOTION OF SLIDES AND REVERSING GEAR; GEO. RICHARDS AND CO., LTD.

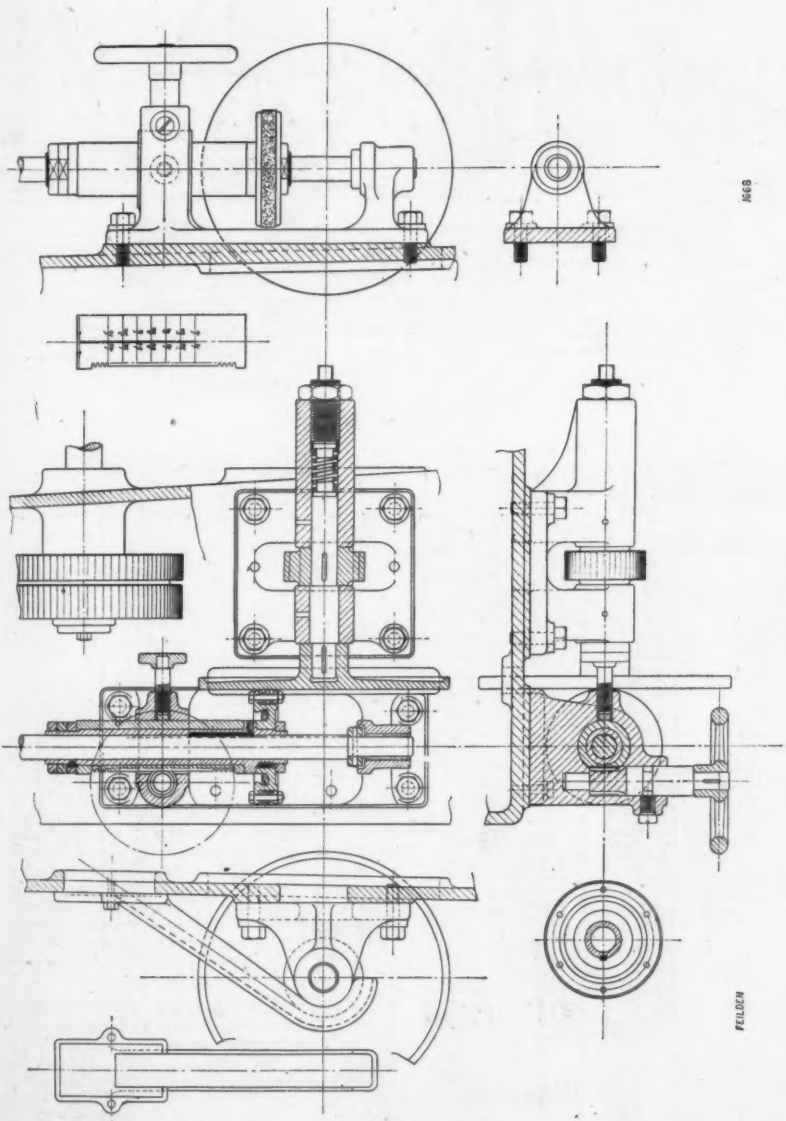


FIG. 3.—TURRET-HEAD BORING MILL.—DETAILS OF FRICTION DISC ARRANGEMENT: GEO. RICHARDS AND CO., LTD.

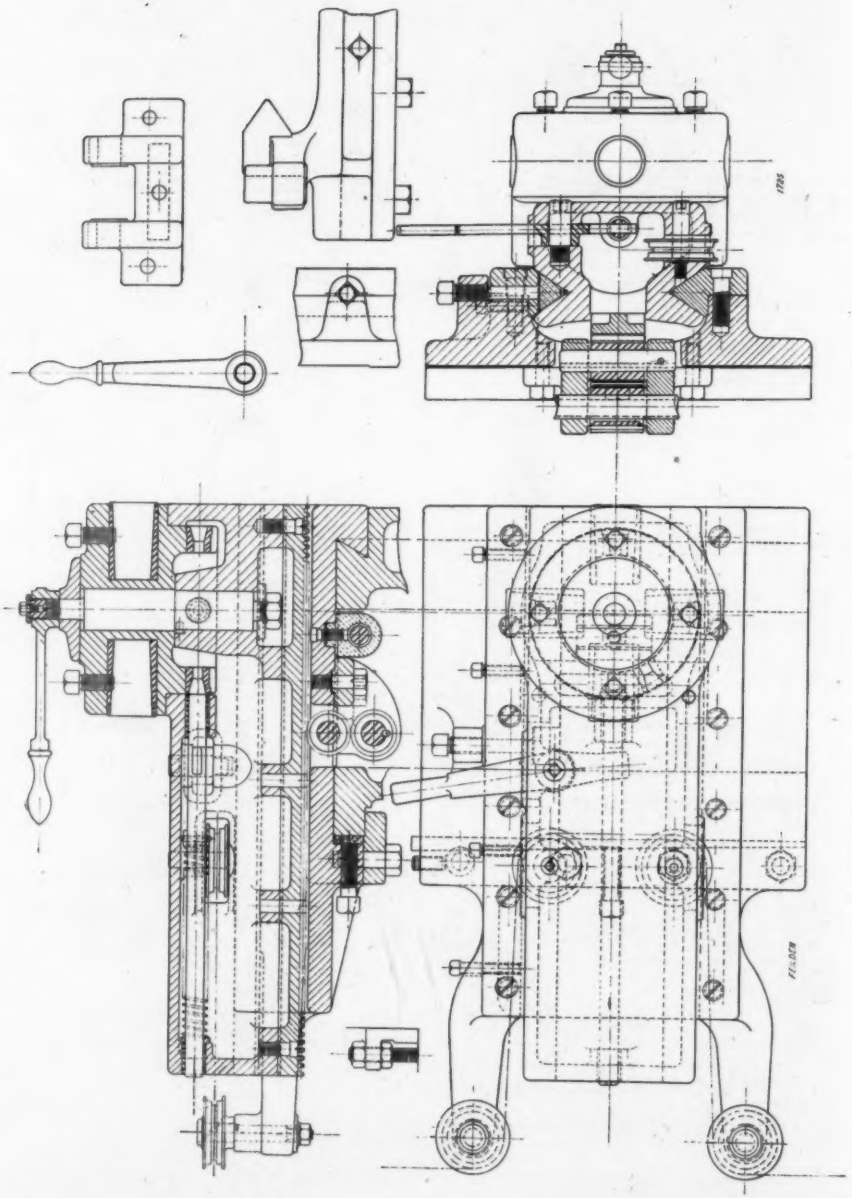


FIG. 4.—TURRET-HEAD BORING MILL.—DETAILS OF THE TURRET: GEO. RICHARDS AND CO., LTD.

WORKSHOP PRACTICE

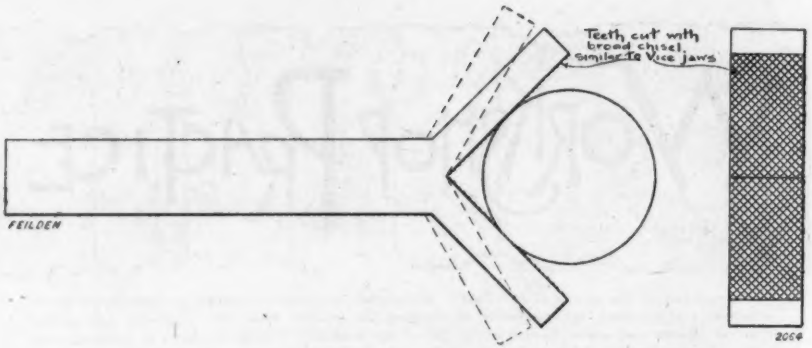
The purport of this section of FEILDEN'S MAGAZINE is to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is what we desire to encourage and foster. To this end we invite skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which, if accepted, will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for publication. Nothing will be too poor for a careful inspection. It will be seen that those contributions which appear in this section show distinct merit, and are both interesting and instructive.

Tool for Turning Rubber Rollers.—This can readily be made from a piece of ordinary tool steel, split and opened at one end, as shown in the accompanying drawing. The inside of the jaws thus formed must be cut with a broad chisel to form a surface similar to the jaws of a vice. When in use it is simply fastened in the tool-rest like an ordinary turning tool, and the same tool can be used for turning a number of sizes of rollers. The dotted lines indicate that it may be opened out for turning larger rollers. J. H. H.

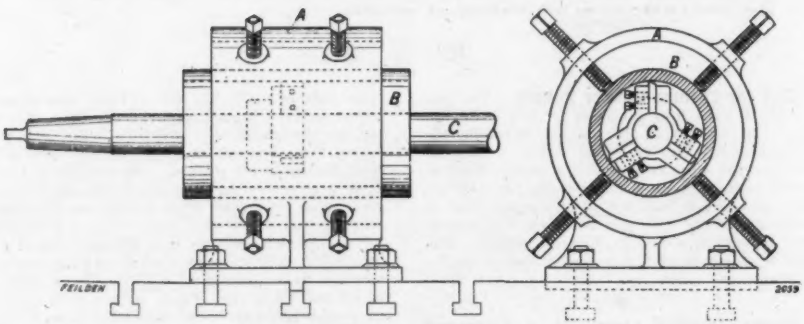
Boring Cylinder Liners on a Horizontal Boring Machine.—The boring of cylinder liners, and bushes of all sorts, can be readily done on a horizontal boring machine by means of the arrangement shown on the accompanying drawing, which latter largely explains itself. *A* is a hollow cylindrical casting with a planed base bolted to the boring machine table, and having eight adjusting screws through it for setting the liner. *B* is the liner to be bored, and *C* the spindle of the machine with the cutter head attached. The liners or bushes can be bored much quicker by this method than when done in the lathe, owing to the stiffness gained, due to there being no overhanging parts. A few different sizes of the casting *A* will be found to cover a wide range of work. "FABER."

Geometry for Metal Plate Workers.—The following is a good way of developing the pattern for an inclined branch pipe, as in Fig. 1. First set out the outline of the two cylinders as *ABCDEF*, making *GDA* the required angle. Then on *AB* and *GF* describe semicircles, this giving the shape of half the pipe. Divide the semicircle drawn on *AB* into any number of equal parts, as *b*, *c*, *d*, etc., and from these points draw lines parallel to the line *BC*. These now represent a series of lines drawn on the pipe, and if we can determine the length of these lines to where they intersect the pipe *CEFG*, this will give the required pattern. From the points, 1, 2, 3, 4, where the lines touch the edge of the pipe, draw horizontal lines, cutting the line *GO*, which is *GF* produced. From the line *GO* mark off along the horizontal lines distances equal to 4*d*, 3*c*, 2*b*, and 1 respectively. A line drawn through these points gives a quarter of an ellipse, as shown. From each of these points, 1^1, 2^1, 3^1, 4^1, drop perpendiculars to cut the semicircle on *GF* at the points *L*, *M*, *N*. Now from these points draw horizontal lines along the pipe *EF*, until they intersect the lines on the pipe *ABCD*. Where these lines intersect is the true length of the lines, and a line drawn through the points of intersection gives the shape of intersection. To produce the pattern as in Fig. 2, set off a line *AA*, and along this line mark off twice the number of distances that are marked on the semicircle *AB* (Fig. 1), the distances on the line *AA* being equal to those on the semicircle. This will give a line, *AA*, equal in length to the circumference of the cylinder. From each of these distances on the line *AA* draw perpendiculars. These will then represent the same lines on the pipe *ABCD* (Fig. 1) in development. Commencing with the centre line, mark off a distance, *BC*, equal to the line *BC* (Fig. 1). Then on each side of this line mark off the lines equal in each case to the corresponding lines in Fig. 1; a line drawn through the points thus marked gives the shape as in Fig. 2 of the pattern required. All allowances for joints to be added. E. COPE.

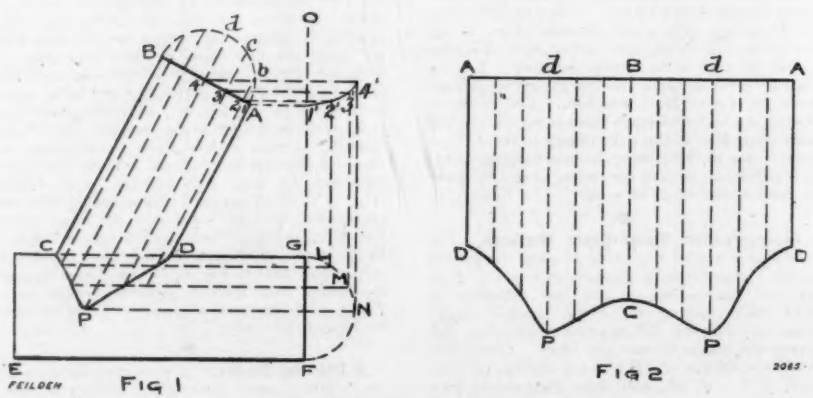
A Drilling Device.—It sometimes falls to one's lot to have a small quantity of articles to make



TOOL FOR TURNING RUBBER ROLLERS.



BORING CYLINDER LINERS ON A HORIZONTAL BORING MACHINE.



GEOMETRY FOR METAL-PLATE WORKERS.

which involves the drilling of a hole two or three inches long centrally through each one, or practically through each one, leaving, say, a shell bottom $\frac{1}{16}$ in. thick. If a sufficient quantity is required a drilling jig is made, and the matter is simple; but when the quantity is small it may not pay to make a jig. I had a case of this sort a short time ago. The article was $2\frac{1}{4}$ ins. long, $\frac{1}{16}$ in. irregular diameter (three flats and a half round), and it was desired to drill a hole $2\frac{1}{8}$ ins. × $\frac{3}{16}$ in., with a small hole through the remaining distance $\frac{1}{16}$ in. in diameter. These tubular articles were furnished with two flanges for the special purpose for which they were intended, but these made no difference in the method adopted for drilling them. If, however, a drilling jig had been made, the necessary cutting would have formed a formidable item in the cost. Attempts to drill the articles on centres whilst holding them in the hand were found impracticable, so the following method was adopted. A straight bar of iron, *A*, 30 ins. × $\frac{1}{2}$ in., was taken, and at one end two holes, *B*, were drilled about 2 ins. apart. Pieces of silver steel were driven through these holes, and were left standing out on each side of the bar $\frac{1}{16}$ of an inch. These formed a platform, on which two of the articles, *C*, one on each side of the bar, were placed; and a cramp, *D*, was then slipped over the bar, and the two articles securely cramped to it, their sides resting on the sides of the bar, and their bottoms on the platform pegs. This ensured their being held firmly in lines parallel to the bar of iron in both directions. Before being cramped on each of the articles was accurately centred at the one end to receive the point of the drill. At the other end of the bar a small plate, *E*, was securely riveted thereon; then, working from the centre of the bar, *A*, the exact positions of the centres of the articles were lined out on the plate, small holes, *F*, were drilled in the positions marked, and the apparatus was ready for trial. The holes in the plate were utilised to fix the position of the plate upon the back centre of an ordinary lathe, the drill was placed on the corresponding centre in the article, and the work was speedily turned out. To counter-balance the weight of the bar upon the drill, the bar was allowed to revolve slowly in the hand during the process of drilling. This bar-holder was a success, turning out the work quickly and accurately. Its success was largely due to having obtained a long distance between the back centre of the lathe, where the pressure was applied, and the point of the drill, where the work was being done. The bar of iron must be sufficiently strong to remain rigid under the pressure, and not bend.

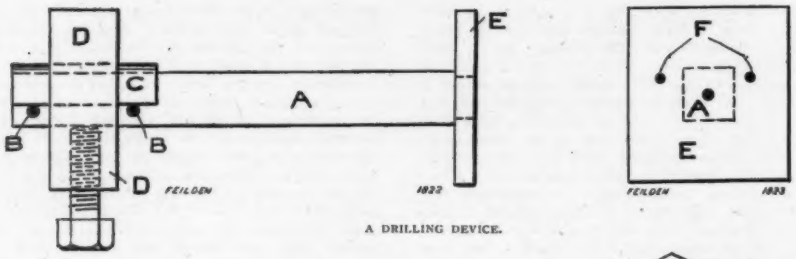
S. Mills.

A Powerful Gas Heater. — The following is a description of a powerful and handy form of gas jet for expanding cranks, etc., when shrinking on to their respective shafts and pins, and when an hydraulic press is not available. *A* is an iron casting, the outside diameter of which is a little larger than a 2-in. gas pipe; A^1 is a 1-in. gas pipe screwed into this casting; *B* is an ordinary 2-in. gas coupling, with a T reduced to 1 in.; *C* is a piece of 2-in. gas piping; *D*, a blank flange screwed on, and plugged up at the bottom; *E* a gas coupling (slotted on the top cast-iron extension pipe, and fastened with a small set-screw, as shown); *F* is an ordinary 1-in. gas bend; *G* and *H* are 1-in. gas pipes, to receive their rubber pipe connections for conveying gas and the air blast. Place the heater or heaters directly under the article to be operated upon, and couple gas pipe up to gas mains with a rubber pipe, and air pipe to a fan or bellows, as used for blowing smiths' fires, or to a portable fan or bellows if for outside work. If a good air-pressure is maintained, this heater will quickly heat large cranks, and expand them to slide on or off their shafts quite easily. The writer has seen a crank removed from a 15-in. shaft in under one hour, with two of these jets playing on it, care being taken to keep the shaft as cool as possible by means of a water-jet or other suitable method. When complete this heater only weighs about 14 lbs., and is so cheap to manufacture and certain in its action that it is well worth a place in any engineer's shop, and especially for outside repair work.

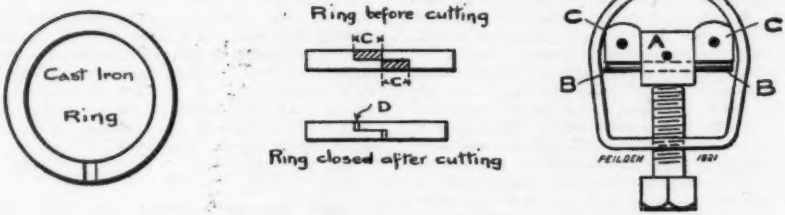
J. Green.

Small Pistons. — Nearly every engine-fitter and mechanic, at one time or another, has experienced trouble from leakage with the ordinary type of small cast-iron block piston, fitted with one ring only. The usual method of producing the rings is well known, a ring of cast-iron being turned to the size and section required, from $\frac{1}{8}$ in. to $\frac{3}{16}$ in. larger in diameter than the bore of the cylinder, according to the size of the cylinder in hand. The usual way to cut the ring is by taking the bench saw, and cutting through the thinnest section at an angle of about 45 degrees, and removing the portion of metal *A* sufficient to allow the ring to close a little under the diameter required. This arrangement is not usually a good enough job for the present increased pressures, and more particularly is this the case in gas and oil engines, the pressure escaping at *A*. A better method of overcoming this leakage, when renewing the ring in a piston of this description, is by cutting the ring in the following manner, when, if carried out in a workmanlike manner, no further trouble from leakage at the ring joint will be experienced. Turn and bore the ring to the required section, allowing $\frac{1}{8}$ in. to $\frac{3}{16}$ in. larger in diameter than the bore of the cyclinder, then mark out as shown on the thinnest or weakest section of the ring. The distances *C* should be $3\frac{1}{2}$ times the difference between the bore of the cylinder and the diameter you have turned the ring, plus about $\frac{1}{8}$ in. for clearance. Carefully secure the ring, and file away the portions shaded on sketch, taking care to finish all you can before breaking through; now close up the ring, use calipers, and see that the joint does not exceed the width of the turned part; also see that the clearance at *D* will allow of the ring being closed to a little under the bore of the cylinder, as sometimes (in repair jobs more particularly) the cylinder diameter will vary a little.

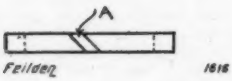
James R. Kelly.

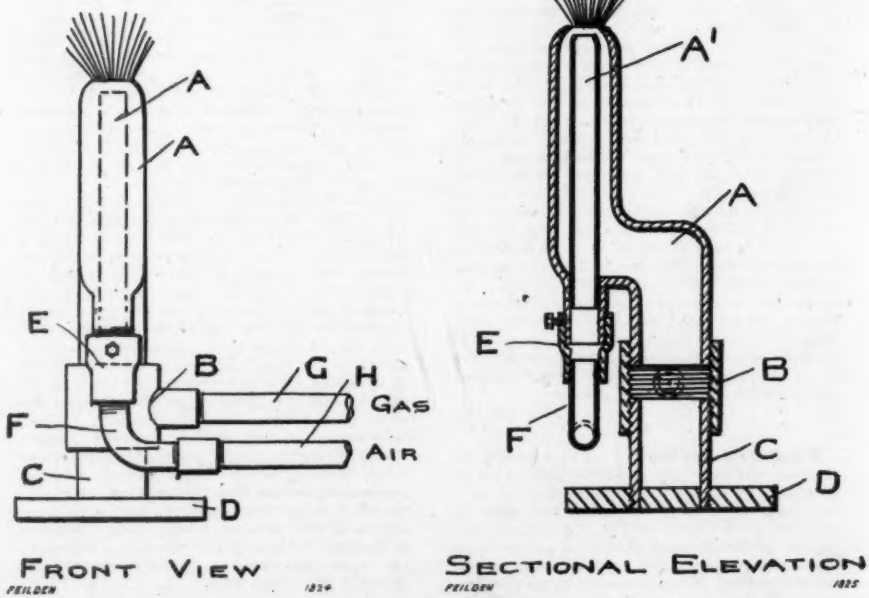


A DRILLING DEVICE.



SMALL PISTONS.





A POWERFUL GAS HEATER.

PRACTICAL ARTICLES FOR PRACTICAL MEN.

NOTES AND COMMENTS ON SOME INDUSTRIAL TOPICS, BY JAMES VOSE.

THE following notes and comments are in response to a suggestion by the Editor that such—from the point of view of one occupying an intermediate position between employer and employed—would be in order at the present time. From an almost bewildering number of topics interesting to the student of industrial evolution, I will make the following arbitrary selection :

Foreign competition ;

Trades Unions of employers and employed (some current misconceptions concerning them) ; and—

The recognition, utilisation, and appreciation of different types of ability, reserving some remarks on technical or equivalent training of employers and employés, the selection of intermediaries, and the necessity for definite policies in the conduct of industrial concerns, for a future issue.

Regarding foreign competition, so far as I can gather, what may now be called the old school of alarmists, who based their fears of a British industrial decline on the long hours worked by, and the low wages paid to, foreign workpeople, must now change their ground. It appears to be pretty generally conceded by investigators, that it is the best paid and treated foreign labour which is chiefly to be guarded against. Indeed, some German economists of repute have urged on their Government, that if that country really wishes to compete fairly and squarely with Great Britain in certain lines, its population must be so remunerated as to be able to live up to the standard of the British artisan, a standard which in some respects is improved upon by that of the American workman. Personally, I think that when our employers and workmen are really convinced of the actuality of and need of directly meeting foreign competition, that we can hold our own in every legitimate direction. Some of the qualities and features which have contributed to the building up of our industries, as, for instance, gradual growth and solidity, do not at first sight appear to advantage when suddenly confronted with new conditions, but they at any rate prevent panic, and tend to allow things to gradually conform to changing demands with a minimum of loss. Of course it would be folly to be blind to the natural advantages of other countries when these are utilised to the fullest practical extent. As a case in point : when the enormous mineral deposits of the United States are won on a carefully considered and gigantic scale, with financial and manufacturing facilities to match, our steel manufacturers will be compelled to put their houses in order, or be prepared to occupy a very subordinate position during slack times. But if a large share of the profits received during the present period of prosperity is expended by our mining, smelting, and iron and steel manufacturing concerns on more efficient organisation and plant, this country ought to withstand business depression more easily than the States. Our business methods, though sometimes exasperatingly slow to the "hustling" Americans, are much more safe and reliable than what an observant and fair-minded American describes as the "catch as catch can" principles of business obtaining in America. The same writer, commenting on our careful "getting out" of quantities for estimating, appreciatively compares our "orderly and dignified" methods of obtaining and executing orders with the previously mentioned methods to which, he says, the Americans for good or evil seem committed. The American Consul in Birmingham has also pointed out that the American "lack of business patience" in the bolt and nut business has simply resulted in the American manufacturers making a considerable present to foreign customers with no corresponding advantage, but only injury, both to themselves and British manufacturers. No doubt there will be more or less fluctuation in the relative position we occupy in the world's markets, but if we for any undue length of time decline considerably in any leading speciality, I think it will be our own fault, and in "we" I include all ranks ; and we shall deserve our fall.

As to Trades Unions, such organisations of employers and employed appear to me under present circumstances more or less necessary—necessary evils perhaps. Though they tend to lessen the individual initiative of progressive workpeople and employers, they at the same time compel laggards on both sides to "toe the line," and, by helping others, thereby help themselves. A large amount of cant has been, and is, indulged in by more or less ill-informed writers as to the

character and aims of the more prominent representatives of capital and labour. To judge by the statements of extreme partisans of "the workers," one might conclude that all employers lived and enjoyed a considerable competence by "grinding the bones" of the "producers." By none has such an attitude been more scathingly condemned than by Mr. Jas. Mawdsley J.P., the General Secretary of the Operative Cotton Spinners. Col. Dyer was, during the progress of the late engineers' dispute, probably one of the most maligned of men, but there is every reason to believe that if spared, much of his organising and directing ability would have been devoted to proving, in an unmistakable and palpable way, that the anxiety evinced by the employers during the dispute that the best workmen should have no artificial hindrances placed in the way of their advancement —pecuniary or otherwise—was no mere benevolent after-dinner platitude, but the prelude to immediate recognition and adequate remuneration of meritorious workmen. A recent instance of the steadying effects of large organisations is the amicable settlement of the recent demand of the cotton operatives for a 5 per cent. advance in wages. After orderly and mutually respectful discussion by the representatives of both parties, the advance was granted, and by the terms of agreement, no demand from either side for an advance or reduction of wages can be entertained within a period of one year. A favourite description by some writers of trade union officials (workmen's) represents them as simply agitators, or pestilent fellows "fattening on their dupes." Anyone having merely a surface knowledge of the work performed by, say, Mr. Knight of the Boiler Makers, Mr. Mawdsley of the Operative Cotton Spinners, etc., will acknowledge at once that their remuneration does not err on the side of extravagance. In fact the position of General or Provincial Secretary to the large unions of employers and workmen demands for its satisfactory occupation abilities of a high order. That the employers' unions do not endorse the "fattening-on-their-dupes" theory is shown by the fact that Mr. Hill, the former Secretary of the Bolton Operative Cotton Spinners, relinquished his position to take up a similar appointment with the Bolton Master Cotton Spinners Association. Also, the gentleman who recently received next to the highest number of votes for the position of General Secretary to the Boilermakers, being called on through special circumstances to take up the post in lieu of the elected candidate, was found to have been installed in an analogous post, at a higher salary, by an employers' association. Similarly a statue, subscribed for by all classes of the community (employers being well represented in the matter), was a few years ago erected in Victoria Park, Bolton, to mark the esteem in which Mr. J. T. Fielden, J.P., a former operatives' secretary, was held by his fellow townsmen and representatives of associations further afield. The *Manchester Courier*, in remarking on the event, stated that Mr. Fielden's greatest claim to regard was the large number of disputes nipped in the bud through his wise counsel and thorough knowledge of the trade. The employers in several instances have set an excellent example by employing solicitors as their secretaries, and it appears to me that the payment by Trades Unions (workmen's) to their leading officials of salaries equal to those drawn by professional men of good standing would, providing men of a calibre corresponding to the salary were selected for the post, and the selection ground not limited to members of the unions, be a good investment. Gentlemen of professional repute in the various branches of industry might then find it worth while to offer their services indifferently to either employers or workmen. I am not sanguine, however, that workmen will be sufficiently broad-minded or far-seeing to take any such course for some time to come at any rate. The whole question of Trades Unionism is summed up by Mr. Herbert Spencer in his "Study of Sociology,"* in the section dealing with the Class Bias, wherein he demonstrates that such class organisations exist, not in consequence of their intrinsic equity, but because, for the time being, no other plan answers so well.

There is an old saying that "it takes all sorts of people to make a world," and the same idea appears applicable to the making of a successful engineering works. The ideal all-round engineer would combine in his own person such a variety of qualifications as is seldom likely to be possessed in well balanced proportions by any single individual. This proposition is at the present day more or less admitted. Taking it for granted, it would imply that if works' principals would more often conform to the counsel of the highest authority, and sit down and "count the cost" of initiating or continuing their businesses, they would in most cases come to the conclusion that the tasks of correctly deciding what to manufacture, laying down the lines on which such manufacture should proceed, specifying the classes of ability most essential to the efficient carrying on of the chosen business, selecting satisfactory occupants of

* See "The Study of Sociology," Kegan Paul, Trench & Co., London.

the posts thus indicated, and focussing the results of the labours of all concerned for future guidance, would suffice to absorb the reasonable energies of any normal individual or body of directors. As examples of the different types of ability required in a modern engineering works may be mentioned

THE ENGINEER,

who lays down the conditions to be complied with, and indicates what is best calculated to fulfil the conditions, and the principal dimensions of the finished product.

THE DESIGNER,

who, starting with the above data, makes such use of it that the outlines and contours of the finished work give the instant impression that harmonious outward expression has been given to the correct underlying principles.

THE MECHANIC,

or production expert, who, in his mind's eye, sees each detail from its inception through the pattern, foundry, machine, and other departments, and intuitively suggests the most satisfactory and profitable methods of production under the conditions obtaining.

THE TOOL-MAKER,

or highly skilled all-round workman, who makes the mechanic's methods attainable.

THE OVERSEER,

or departmental disciplinarian, and the

PRINCIPAL AND SUBORDINATE OFFICIALS

of the commercial side of the business, who will include representatives of the classes of ability to which the financial, order-securing, cost-dissecting, and estimating, accountancy, and general routine features of the enterprise appeals most forcibly.

A well-organised works will employ in congenial spheres each of the above types of activity, plus, in some cases, individuals occupying deliberately loosely-defined positions of great influence in special matters. It does not follow that every class of talent need have its particular exponent in every works, as small or medium-sized growing concerns may frequently require one person to discharge several functions, but it appears to the writer essential that each official should feel secure and adequately appreciated and supported in the exercise of his duties. The *esprit* displayed in the attack on their individual problems or tasks in a works where each individual is aware that a guiding principle in its management is that—given ungrudging activity in each sphere—none is considered "afore or after other," must be an invaluable factor in the firm's ability to successfully meet commercial competition. The most valuable feature of this spirit is that up to the present time the limits of its beneficial action have apparently not yet been reached. The conception of such a works will, perhaps, be considered Utopian by many, but a striking exemplification of successful application of some such principle as just outlined is in operation in the case of the Cash Register Company, Dayton, Ohio. This corporation appears to have been snatched from bankruptcy, and placed in such a position that its products are in use in every commercial centre, simply and solely through the employment of methods which many business men would at once pronounce almost childish, and certain to result in complete ruin. However, the Cash Register Company continues on its unchecked career, full particulars of which may be found in back numbers of the *American Machinist*.* With respect to the best method of appreciating the several classes of ability previously indicated, one cannot do better than quote the ever-green "Chordal"† on the subject. Speaking of an employer complaining of the action of another employer who had "stolen" several good workmen from him, he says, "I have had men stolen from me, and called the stealer a thief. I have stolen men from other folks, and been called a thief. I have been stolen myself, and always had the most respect for the biggest thief. The way to get men is to pay them their value, and the man gets and holds his place by making himself valuable."

* See pages 225, 240, and 249, *American Machinist*, 1897 vol.

† See "Extracts from 'Chordal's' Letters": Chapman and Hall, Ltd., London.

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INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION FROM ALL SOURCES.

CIVIL ENGINEERING.

The Port of Emden or the Dortmund-Ems Canal.—During the present summer the Dortmund-Ems Canal, connecting Westphalia and its coalfields and ironworks with three ports on the lower Ems, *i.e.* Papenburg, Leer, and Emden, was opened to traffic. The latter port, which is on the Dollart, has had to be widened and transformed into a seaport; it forms the terminus of the canal. Up till 1277 the Dollart was an inland lake, separated by a wide bridge from the North Sea. The rupture of that natural dam caused a change in the lower course of the Ems River. Up till recent years the inner harbour had two locks; the Jade Canal of 1882 brought a third lock, connecting the inner and the new outer harbour. This lock has a length of 120 metres, 375 ft., but is navigable only for boats of 100 m. in length, 15 m. beam, 6 m. draught (328, 49, 20 ft.). The inner basin has been enlarged and deepened, but something remains to be done for the outer harbour, which was formerly a sea canal. Quay walls, sheds, rails, and electric cranes have been erected and laid, and the basin has now a length of 1,300 m., a width of 120 m., and a depth of 9 m. (4,250, 375, 29.5 ft.). At low water there remain only 8 m. of water, and this depth is to be increased to 12 m. (39 ft.). To maintain a navigable channel of a depth always sufficient for vessels of 9 m. draught will not be an easy matter. But the future of the port largely depends upon that channel. Bucket and suction dredgers are employed.

MECHANICAL ENGINEERING.

Demand for Hosiery Machines.—H.M. Consul at Philadelphia has sent to the Foreign Office a report in which he points out that Cotton's Patent Full-Fashioned Hosiery Machines (power machines), which are of British origin, are at present in great demand on the Philadelphian market. He adds, that hitherto these goods have been shipped direct from Germany, but the supply is unequal to the demand, and it appears, therefore, that other machines of British make would have a good opening if they can be supplied at prices similar to those paid for German machines. The latter are priced as follows: Ladies' 18-Section Legger, 7,000 marks; Men's Half-Hose Legger, 6,000 marks; Footer Machine, 7,000 marks. These prices are exclusive of customs duty in America, but include erection there. The duty amounts to from 2,000 to 3,000 marks according to the machine. The price paid for an 18-Section Ladies' Legger, 33 gauge, has been as high as 2,750·00 dollars in the United States, delivered in factory in running order, and the price under the same conditions, delivered in factory, for footer and men's half-hose legger, 33 gauge, is about 2,650·00 dollars. The Consul adds, that he is informed that after the election considerable numbers of these machines will be required for immediate delivery. The importing houses for Philadelphia are:—Mr. Wolfgang Richter, N.E. Corner 3rd and Green Streets, Philadelphia, and Mr. Paul Schlowsman, 2,726 Mutter Street, Philadelphia.

Agricultural Implements.—To judge from the monthly bulletin of the Société d'Encouragement pour l'Industrie Nationale, for Sept. 30th, enterprising british manufacturers might benefit the inhabitants of the large plain of Caen considerably, and obtain good profit themselves, by importing into that district up-to-date agricultural implements of simple and solid construction. This plain is well-adapted to the use of machinery, but, strange as it may seem, the implements used as yet by the tillers of the soil are of the most primitive kind, consisting of the ordinary plough of the country, the large harrow with either wooden or iron teeth, the small harrow with wooden teeth made of ash, and the wooden roller. Most of these implements, moreover, are defective. Drills would be useful throughout the district, but they are almost unknown; reaping machines, which would be equally desirable, are never used, and the harrow and machine-plough are nowhere to be found. Even grain-sorting machines, which would be of the highest value to the farmer, are lacking as yet on the majority of farms. Much, therefore, may be done in promoting agricultural progress in the plain of Caen, and the pioneers in this direction would no doubt reap a high reward.

Alcohol Plough Locomobile.—According to a report of the United States Consul-General at Frankfort-on-Maine, a new alcohol plough locomobile was recently exhibited in the presence of a number of experts at the motor factory of Oberwesel. This locomobile was one of 20 h.p., and intended to be worked with alcohol, which could be economically produced, as fuel, instead of coal.

The work performed by the plough was as effective as that done by a steam plough. The problem of using alcohol for power-purpose has been solved, it seems, by the motor factory in evaporating denaturalized alcohol of 90 degs. The construction and operation of the motor is that of a gas motor. The consumption of alcohol averages about one pint per hour per h.p., while the expenses are said to be 25 per cent. lower than those for steam.

ELECTRICAL ENGINEERING.

Suggestions for a New Tube Line.—The undoubted success of the underground electric line from Shepherd's Bush to the Bank is, naturally, suggesting schemes of a similar nature to many persons, and manuscript dealing with such plans arrives in considerable quantity at the offices of the daily papers, intended for publication in the correspondence columns. Occasionally something worthy at least of a passing notice, makes its appearance, and to this class belongs the letter recently published by the *Daily Express*, containing a proposal to change a portion of the Metropolitan District Railway into an electric line. "The Metropolitan Railway," says the writer, "have missed their chances, and have now always a formidable competitor from end to end of their London line. But with the Metropolitan District the case is different. They have a line running from Putney and Wimbledon right through London to Bow, and with a population at each end, and all along the line, of over a million. Let me point out to the District Company what they could do by spending about £1,500,000. First, they must introduce electric traction, and the tunnels must be cleaned and made bright with glazed tiles. The stations must be provided with lifts, and in many cases they should be rebuilt and the space which is now wasted could be economised, and building sites leased which would be of great value. Take one instance—Mansion House Station. At present a ramble of two minutes and many stairs bring you to the platform. Rebuild that station, put lifts directly on to the platforms, and you have room to build the best restaurant in the City, and at the same time get a station with double the accommodation. The restaurant would readily let for £4,000 annually, which is 4 per cent. interest on £100,000." The writer further points out that the same might be done at many of the other stations along the line, and suggests the construction of lifts for lowering coal vans and other vehicles which might be put on the trains and carried in the night to points as near as possible to their destination to which they would ultimately proceed by road. He also enters a plea in favour of night service, which would be of immense benefit to thousands of persons who then could live in the healthier suburban districts of London, being sure of being able to reach them during the small hours of the early morning, after having finished their nightly labours. This latter plea, of course, forcibly appeals to all whose duties lie within the neighbourhood of Fleet Street, and it is undoubtedly to be regretted that the metropolis of the world is so far behind the metropolis of the United States in catering for the comfort of night-workers, who constitute a numerous as well as a very useful portion of the bread-winners in all great cities.

IRON AND STEEL.

German Armour-Plate Manufacture.—A letter from Baron Stumm, one of the chief armour-plate manufacturers, is contained in a recent report of the Committee on Naval Affairs of the German Reichstag, in which the writer states that he is compelled to make a statement in order to correct the allegations of certain newspapers. The business profits of the Krupp and Dollinger works on armour-plates, he says, had been quoted as amounting to 176,000,000 marks. The new armoured ships required 49,000 tons of armour material at a cost of 113,000,000 marks. Therefore, even if it were taken for granted that half the price constituted a clear profit, this would amount only to 56,000,000 marks, which, divided over sixteen years, would be 3,500,000 marks annually, or 1,750,000 marks for each concern. The manufacture of armour-plate, he continues, is very difficult; within 20 years the method of manufacturing has been remodelled three times. The least mistake results in rejection, which naturally entails heavy losses. For years the prices of armour-plates had not been raised, although wages and cost of raw material had doubled. So far the letter. In reply to this, according to the report, the Committee argued that the total demand for armour-plate, based upon the estimates for new vessels and remodelling for the next sixteen years, would amount to the sum of 260,000,000 marks, and not 113,000,000 marks. If, therefore—as would seem to be admitted by Baron Stumm—half was profit, this would amount to 130,000,000 marks, which would be divided between only two firms. A net profit consisting of half the contract price was exorbitant. Therefore a termination of the monopoly, either by the establishment of works by the Empire or by the participation of trustworthy competitors, appeared to the Committee as strongly advisable. An inquiry was also made, as to whether the nickel-steel armour of those vessels which had to be replaced could not again be used. To this the representatives of the Government replied that an answer to this question could not, at present be given, since the condemnation of old armoured ships, so far, had not applied to nickel-steel armoured vessels, but only to common iron-armoured ships, and these armours are no longer used. The monopoly question was of great importance to the Navy Department; such monopolies existed not only for armour-plates, but also for guns and ammunition. The manufacture by the Empire would be an enormous undertaking; furthermore, it was not certain whether the profits on armour-plates were really as high as they appeared, when the capital invested is taken into consideration. The aim of the Department, however, was certainly to

encourage competition and to break monopolies. It was pointed out that this aim could be attained by the passage of the bill, since this would guarantee permanent work for shipbuilders. One of the members of the Committee referred to the statement recently made by a member in the Reichstag, that England was building her ships 20 per cent. cheaper than other countries. If this were so, it would make a difference of 248,000,000 marks to Germany on her new and remodelled vessels. The representative of the Government replied that the reason might be that the English shipyards were well appointed in every particular, that material and coal were somewhat cheaper in that country, and, above all, that keener competition existed in England between shipbuilders.

Circular Saw Making.—According to the *American Manufacturer*, circular saws are now made of cast steel specially manufactured for the purpose. An ingot heated to the requisite temperature is reduced to the proper thickness in powerful rolls. The plate is then centred and a circle inscribed upon it, after which it is passed to the shearer, who reduces it to a circular form. The centre hole is bored, and the plate is then handed to the toother, who punches out the teeth around the edge, after which they are rough-filed or ground on an emery wheel, to take off the burr left from punching. The rough saw is again heated in a large furnace until it is of a bright red colour. It is then plunged into a bath of sperm oil, which makes it hard and brittle. The oil is then partly cleaned off, and the rest burnt off in a furnace to give the saw the required temper. When cold, the saw is hammered on a steel-faced anvil until it is straight. It is next ground between vertical grindstones revolving in opposite directions, and then polished with emery on a large disk. Once more the hammermen take it, and strike it with smooth-faced hammers on an anvil as before until it is absolutely straight and true, and has acquired the proper tension which allows for expansion while the saw is revolving at work. The teeth are now set, alternately right and left, to allow for clearance when sawing timber. They are then sharpened by being filed on the front and tops of the teeth, which operation completes the manufacture.

RAILWAY WORK.

New Railway in Formosa.—According to the *Journal des Transports*, of October 6th, the construction of a new railway in Formosa has been decided upon. The line will run from Taihoku (Taipech) to Tamsin, passing through Maruyama, Shirim, Hokuto and Kantan. These towns are health-resorts of importance, and will assure to the line a fair amount of traffic. The track will have a gauge of 3 ft. 6 ins., and it will be necessary to build thirteen bridges (two of large dimensions). For the working of the line, the disused material of the Kelung-Teckcham Railway (which has been almost entirely renewed) will be utilised. The line will complete the railway system of Formosa. It is estimated that six locomotives, a considerable quantity of rolling stock, 60 miles of rails (60 lbs.), and 400 tons of material for the construction of the bridges, will be required.

SHIPBUILDING.

Launch of a Hopper Barge.—Messrs. Wm. Simons & Co., Ltd., launched from their yard in Renfrew, in the forenoon of October 19th, the 600-ton hopper barge *Avon*, which is the second of two hopper steamers constructed by them for the Bristol Docks Board. The vessel is fitted with two sets of triple-expansion engines of 650 i.h.p. combined; steam being supplied from one large steel multitubular boiler constructed for a working pressure of 160 lbs. per sq. in. The hopper doors are controlled by two independent steam engines, connected to the winches placed on fore and aft ends of hopper. Steam steering gear, and all the latest improvements in vessels of this class are provided on board. The construction of both vessels was supervised by Mr. W. W. Squire, M.I.C.E., engineer-in-chief of the Bristol Docks Board.

MINING.

Gold Deposits to be leased in Russia.—The Mining Department of the Imperial Russian Ministry of Agriculture and State Domains announces that on January 28th (15th old style), 1901, at 2 p.m., a public auction will be held at their premises, in St. Petersburg, for the leasing to private individuals or companies of the auriferous deposits of the north-western shore of the Sea of Okhotsk. Applications to take part in the bidding will be accepted from Russian subjects as well as foreigners, alike from private individuals and companies. Persons or companies intending to take part in the bidding, can obtain information as to the allotment, and full particulars on the lots, by applying personally or by letter to the Imperial Russian Financial Agency, at their offices situated at 107, Cromwell Road, London, S.W.

MUNICIPAL ENGINEERING.

The Polarite System of Bacterial Oxidation.—The little town of Southwold, in East Suffolk, a watering-place constantly growing in favour, tries to deserve it by paying careful attention to sanitation. About a year and a half ago a sewage disposal system in which, by means of a highly-porous mineral called Polarite, a rapid oxidation of the sewage is effected, was installed, and has since that time been working under the supervision of Mr. Frederick Ball, the Borough engineer. This system, by which bacterial oxidation is effected with very shallow beds, has given, it appears, very satisfactory results; for the town

officials have decided to apply it to the whole sewage of the town, and a Local Government Board inquiry was recently held by Mr. M. K. North, one of the Board's inspectors, into the application of the Corporation to borrow the sum necessary for carrying out this contemplated extension of the plant. The following are the chief features of the system, gathered from a description given by Mr. F. Ball :—The sewage on entering the works flows into the detritus chambers, in which the organic solid matter becomes broken up and passes away with the sewage in solution, whilst the insoluble and mineral matters are deposited at the bottom. The sewage then passes under suitably-arranged divisional and scum boards and through a self-cleansing inclined screen, all organic matters arrested by it being speedily broken up by bacterial agencies. It next enters the two primary anærobic bacteria beds, where it is evenly distributed by means of rows of 4-in. distributing pipes laid with open joints ; passing through the beds, the effluent is collected near the surface by means of suitably-arranged collecting troughs, delivering into a main trough in each bed, provided with an outlet valve and pipe, each of which delivers into the bottom of one of the two secondary anærobic beds, wherein it is evenly distributed by means of 3-in. pipes laid with open joints, the effluent being collected at the surface by branch troughs, which deliver into an outlet or storage trough. In these beds the sewage is subjected to the action of anærobic bacteria, and the most rapid and complete liquefaction and hydrolytic changes possible are obtained. The outlet or storage trough from each of the two secondary anærobic beds delivers into a valve box provided with automatic intermitters, which, when a certain volume of effluent—which can be regulated at pleasure—equal to three minutes' flow has been stored in the troughs, automatically discharges the stored volume plus one minute's flow into each of the two automatic revolving distributors in the space of one minute. These evenly sprinkle the effluent over the surface of the polarite bacterial oxidation beds, giving three minutes' rest for aëration out of every four minutes, which is equal to 18 hours' rest out of the 24. The objects of the intermittent supply of effluent to the beds are stated to be as follows :—1st. That by delivering comparatively small quantities on the beds with short intervals of rest, the aëration of the beds is more complete, and consequently a higher degree of purification of effluent is obtained than by thoroughly deluging the beds and giving longer intervals of rest. 2nd. That better results are obtained by sprinkling than by continuous distribution ; this has been proved by experiment. Another important advantage of the intermittent system is that it prevents any filamentous growth of *crenothrix* on the surface of the ærobic beds. The effluent is collected from the bottom of the two polarite ærobic beds by drains connected to a master channel which discharges into an effluent inspection chamber, from whence the effluent flows through the outlet pipe into the Buss Creek, a non-navigable tidal creek. The experts who were called as witnesses during the inquiry were unanimous in testifying to the suitability and efficiency of the system, which seems to deserve attention in wider circles.

CHEMICAL PROGRESS.

Barium Peroxide in Transport.—During the recent International Congress of Applied Chemistry, M. Bloche drew the attention of the chemists assembled to a real grievance of French manufacturers of this compound. The barium peroxide industry is a very young branch of chemical manufactures, and had its birth in 1880 in Germany. In France oxygenised water began to be manufactured in 1887. The peroxide then obtainable was 82 per cent. ; at present a product of 92 per cent. is in the market. The raw material for the manufacture is the natural barium carbonate, which occurs in Scotland and elsewhere, and bears the name of witherite. This is dissolved in nitric acid, the nitrate being calcined. A portion of the nitrous oxides formerly wasted are now recovered, and the barium sulphate resulting from the decomposition of the peroxide is also recovered, being turned into sulphide. It is also possible to use the natural sulphate of barium, which is of much more common occurrence than witherite, but since the compound has always to be converted into nitrate the expenditure is rather high. The amount of oxygenised water manufactured at present amounts to from 2,000 to 3,000 tons annually, of which 875 tons are of French origin, representing the aggregate of the output from three French works. In France, however, the transport of barium peroxide is not permitted except in iron casks, and yet the wooden casks which are used in other countries are admitted into the country. This, it cannot be denied, is a real grievance which the French authorities ought to take into consideration.

The Catalytic Processes in the Sulphuric Acid Industry.—M. L. Pierron submitted an interesting report recently to the Congress of Applied Chemistry in Paris, being practically a continuation of M. Franchi's report of 1896, and dealing with the progress made since then in the manufacture of sulphuric acid. According to this report, less sulphur and more blende is used in recent years, especially in Belgium ; in England copper pyrites predominate. Pentagonal and hexagonal lead chambers are being introduced, together with the concentric chambers of Delphace and the chamber groups of Benker. At Harburg and Rendsburg the tangential chambers of Meyer have been adopted. Lead chambers, however, are being in many places dispensed with since the catalytic processes have been so improved as to represent a real success. To Berzelius is due the idea, but for its practical realisation Winckler, Squire and Messel deserve credit, for it was Winckler who made the suggestion to spread finely-divided platinum or asbestos, and to pass over it the sulphurous acid and oxygen to effect

their combination. At present the catalytic process is in use at the works of the Badische Anilin und Soda Fabrik, at those of Meister Lucius and Brüning, at the Verein Chemische Fabrik in Mannheim, at the works of the Zink Industrie Co., at those of Dr. Rabe, of M. Sébillot, and of the Société l'Anhydride, the latter working under the Raynaud-Pierron patents. Concentrated acid of 66 per cent., prepared by the catalytic process, is cheaper than with the older method, and the great demand for concentrated acid in the manufacture of explosives guarantees increasing use for the new process. M. Pierron also dwelt on the increasing use of vessels of platinum, platinum-gold, porcelaine (Blenker) and cast-iron for the concentration of sulphuric acid, and stated that they are to be found already in a considerable number of works.

MISCELLANEOUS.

The Increasing Use of Silica.—Since the manipulation of silica in the oxy-hydrogen blow-pipe is understood, its value, especially for the manufacture of laboratory apparatus, is more and more recognised. Mr. Gaudin, in 1839, discovered that quartz can be drawn into fibres, but the first scientist to make practical use of this fact was Professor C. V. Boys, who re-discovered it in 1887, and utilised quartz-threads for a number of purposes. At present quartz tubes, and also bulbs for thermometers, are being manufactured. The silica employed for this purpose is rock crystal, which, when perfectly clean and freed from all outer impurities, is heated in a vessel containing boiling water and then suddenly immersed in cold water. This sudden cooling cracks the crystal, and permits its division into small masses that have to be carefully examined to make sure of their freedom from all foreign substances. The pure fragments are then heated in a platinum vessel to a yellow heat, after which they are quickly thrown into deep cylinders containing distilled water, the process being repeated until the quartz assumes a semi-opaque appearance similar to white enamel. It now can be used in a blow-pipe flame and manipulated somewhat like glass. Geissler tubes, small distillery tubes and thermo meters, may in this way be manufactured from silica, but so far no process has been discovered of soldering electrodes into the tubes. It is said that emerald gives threads even more tenacious than those of silica, and most likely means will be found to render this material even more pliable.

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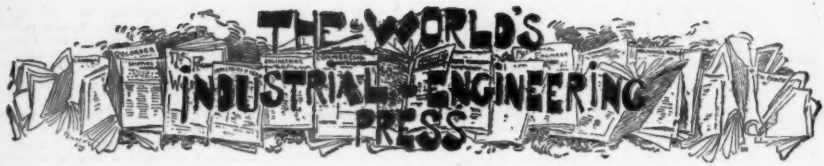

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In this section is presented every month a concise précis of the contents of the leading organs of the technical press and of the proceedings of the learned societies throughout Great Britain, the Continent, and America, and also, in a summarised form, the subject matter of the more important articles appearing therein.

This systematic record should prove of the greatest value to those of our readers interested in one or more specific sections of technology, trade or economics, or to those who have insufficient leisure to peruse the large number of publications now appearing.

In most cases where publications are not readily procurable, with the exception of Transactions of the Learned Societies, copies of the articles can be supplied on application by remitting 7d. Should any of our readers desire further information we shall be happy to supply it.

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ARCHITECTURE AND BUILDING.

1. Construction and Design.

Architectural Curiosities.—*The Paris Exhibition Architecture—A Last Word.* The article severely but justly criticises the grotesque buildings at the great show, especially the so-called monumental gate, the Palace of Mines and Metallurgy, and the Palace of Mines and Commerce, but gives full credit to the masterly design and execution of the Pont Alexandre III.; it dwells on the inanity of the horticultural structures, and the incongruous and trivial structures in the Rue des Nations, making an exception of the Siberian, the German, the Monaco and the Italian Pavilions, and regrets that England was merely represented by a replica of a building obviously unfit for the purposes for which it was intended. (Ill.) 3 cols.—*British Architect*, Oct. 26th 1900.

Church Architecture.—*Two Notable Churches.* The article deals with the church known as St. Dunstan's-in-the-West, the chief ornament of Fleet Street, London, and All Saints' Church, Pavement, York. (Ill.) 1 col. —*The Builder*, Oct. 3rd, 1900.

—— *French and English Cathedrals.* By Francis Bond, M.A. Abstract of a paper read at the Architectural Association meeting by Francis Bond, M.A., in which the author enters upon a very interesting comparison between French and English cathedrals, and sums up his views in saying: "We do not get, it is true, the 'grand nature' in our English cathedrals; they are human, lovable; foreign travel does not spoil one for them; one comes ever back to the sweet loveliness of Lichfield, and Wells, and Exeter, with renewed delight. Amiens, Clermont, Narbonne, are something more than human; it is awe, admiration, almost terror they excite; they seem superhuman, not built for mortal men by mortal men." 7¾ cols.—*British Architect*, Nov. 2nd 1900.

—— *Warlingham Church, Surrey.* By J. Russell Larkby. Description of an interesting village church. (Ill.) 2 cols.—*The Builder*, Oct. 3rd, 1900.

—— *The Statistics of Saxon Churches.* By Prof. Baldwin Brown. VI. Catalogue Raisonné of Examples. This is the sixth instalment of the series, and embraces the remains to be found in the Midlands from Notts and Derbyshire on the North to the Valley of the Thames. (Ill.) 6 cols.—*The Builder*, Nov. 3rd, 1900.

—— *The Statistics of Saxon Churches.* By Prof. Baldwin Brown. This is a series of articles, the main purpose of which is to furnish a summary indicative of the locality, extent and character of the various remains of pre-Conquest churches in this country. (Ill.) 4 cols., 4½ cols., 5½ cols., and 5 cols. respectively.—*The Builder*, Sept. 28th, Oct. 6th, Oct. 13th, and Oct. 27th, 1900.

Foundations.—*Foundations of the Electrical Palace at the Paris Exhibition.* Structural details of the foundation of this interesting iron-frame edifice of a height of 188 ft., in which anchorage moments of 3,280 and 1,050 foot-tons were required for the counterfort and vertical columns respectively. They were secured by expanding the feet of the columns in every direction with solid vertical gusset plates. ¾ col.—*Engineering Record*, Oct. 27th, 1900.

House Frontages.—*The Competitive Designs for the New Strand Frontages.* The article gives a description, accompanied by comments, of the eight designs sent in by competing architects for the new frontages at the Strand end of the new avenue from Holborn to the Strand, and for buildings to be placed in the central area formed in the Strand on the north side of the church of St. Mary-le-Strand. 3½ cols.—*British Architect*, Nov. 3rd, 1900.

Library Building.—*The Oakland Public Library.* Description of a fine library building, containing a number of noteworthy and interesting constructional details. The building, which is not entirely fire-proof, was erected from the design of Messrs. Bliss & Faville, of San Francisco. (Ill.) 1¼ col.—*Engineering Record*, Oct. 13th, 1900.

Moisture-Proof Chambers.—*The Construction of Moisture-Proof Underground Chambers.* B. L. R. Grabill. The author describes an underground dynamo-room so constructed as to be completely moisture-proof, and points out the principles involved in such constructions. (Ill.) 1¾ cols.—*Engineering News*, Sept. 6th, 1900.

2. Heating and Ventilation.

Heating Systems.—*A Large Residence Heating Apparatus.* Description of the heating arrangements recently erected in the residence of Mr. Percy R. Pyne, in Bernardsville, N.J., which is a building of the open type, *i.e.*, offering exposure on all sides, and all its rooms are distributed on two floors excepting nine in the attic. 2½ cols.—*Engineering Record*, Oct. 13th, 1900.

3. Plumbing and Gasfitting.

Plumbing.—*Plumbing in the Cornell Medical College.* Description of the plumbing systems employed in the above-named building, which is a six-storey steel edifice in New York; the plumbing arrangement contains some novel and instructive features. (Ill.) 3¼ cols. —*Engineering Record*, Oct. 20th, 1900.

—— *Plumbing in a Detached Manufacturing Plant.* Description of plumbing in the Weston Electrical Instrument Works, on the outskirts of Newark, N.J., U.S.A. The cold-water supply is pumped into four

12,500-gallon wood tanks in the attic of the power-house, connected by equalising pipes, and the supply for the plumbing is taken at such an elevation that only 2,500 gals. can be drawn through these pipes from each tank, leaving the remainder of the contents available for fire purposes. The distribution mains are taken below the first storey floor, and are carried in trenches, in tunnels and suspended from basement ceilings, to the lavatories, closets, and other points. (Ill.) 3½ cols.—*Engineering Record*, Oct. 6th, 1900.

Water Supply.—*A Simple Water Supply System in a Tall Building.* Description of the water supply in the Queen Building, New York, which is a 17-storey and basement office structure, which furnishes the water for two 150 h.p. Babcock & Wilcox boilers and all domestic purposes. The supply is derived from a simple direct-pumping system. (Ill.) 1½ col.—*Engineering Record*, Oct. 6th, 1900.

4. Miscellaneous.

Architecture in the 19th Century.—*An Architectural Critic in the Year 2000 A.D.* This is the opening address delivered to the Liverpool Architectural Society by the President, Prof. Simpson, on Oct. 8th, 1900, and contains a somewhat caustic criticism, supposed to express the opinion of a writer during the last year of the 20th century. 5½ cols.—*The Builder*, Oct 13th, 1900.

Bank-Fittings.—*Construction of Bank and Office Fittings.* By George Ellis, A.B.I.C.E. Description of what the author declares to be a typical example of the most approved methods of construction employed in this class of work, including specimens of the highest class of joinery. (Ill.) 2 cols.—*Builder's Journal*, Oct. 3rd, 1900.

Lightning Conductors.—*The Functions and Proper Applications of a Lightning Conductor.* Extracts from a pamphlet published by Messrs. J. W. Gray & Sons, of Leadenhall St., London, E.C. The author points out the proper functions of lightning-rods, explaining the theory on which they are based, and giving hints with reference to their erection. 3 cols.—*British Architect*, Oct. 19th, 1900.

Roman Mortar.—*The London Wall and its Mortar.* Interesting description of fragments of the old Roman wall with which the Romans had surrounded, about 360 A.D., the city of London, or Augusta, recently unearthed by Mr. J. Terry, the Clerk of the Works to the Operation, together with an analysis showing its mineral constitution. 3¼ cols.—*The Builder*, Oct. 20th, 1900.

Stone Cutting.—*Mammoth Lathe for Turning Granite Columns.* Description of a remarkable piece of machinery, accompanied by engravings and drawings, being a gigantic lathe for turning granite columns, built by the Philadelphia Roll and Machine Company, of Philadelphia. Pa., U.S.A., and designed and patented by E. R. Cheney and N. A. Spoller, of Boston. (Ill.) 1¼ col.—*Stone Trades Journal*, Nov., 1900.

CIVIL ENGINEERING.

1. Bridges.

Bridges.—*Erecting Three Notable Bridges.* Description of three bridges erected by the Pencoyd Iron Works, viz., the Niagara, Clifton, and Atbara bridges, for which the Franklyn Institute awarded the Pencoyd Works its Gold Elliott-Curson Medal. 2¼ cols.—*Engineering Record*, Oct. 27th, 1900.

—— *The Modified Design for the Memorial Bridge over the Potomac River at Washington.* The article describes certain modifications in the accepted design of Prof. William H. Burr, of Columbia University, required in consequence of a decision of the judges that—contrary to what was at first intended—provision should be made on the main deck for street-car lines. (Ill.) 1 col.—*Engineering Record*, Oct. 13th, 1900.

Cantilever Bridges.—*Reinforcing the Niagara Cantilever. II.* The article gives the details of construction and of the repairing work. 2 cols.—*Engineering Record.*

Footbridges.—*Temporary Footbridge for Placing the Cables of the New East River Bridge.* Description of a footbridge which will consist of a suspended structure of three spans, one of 1,600 ft. between centres of towers, and two of nearly 600 ft. each between the towers and the anchorage piles. (Ill.) 2¾ cols.—*Engineering Record*, Oct. 27th, 1900.

Girders.—*A Seventy-one Ton Plate Girder.* Description of the heaviest girder ever shipped from the Pennsylvania Steel Company's shop at Steelton, and one of the heaviest, although not the longest, single bridge member ever shipped complete by rail, being the middle girder for the four-track bridge on the New York Central and Hudson River R.R., at Oriskany, N.Y. 1½ col.—*Engineering Record*, Oct. 6th, 1900.

Suspension Bridge.—*Reinforcing the Newburyport Suspension Bridge.* The article deals with the reinforcement of the Essex-Merrimac Bridge across the Merrimac River three miles above Newburyport, opened to traffic on Nov. 26th, 1792. (Ill.) 2 cols.—*Engineering Record*, Oct. 6th, 1900.

2. Canals, Rivers and Harbours.

Canals.—*Central American Ship Canal.* No. 1. This is the first of a series of articles which will be devoted to the various projects of a canal through Central America, of which there remain but three: (1) a canal following more or less closely the route of the Panama railroad; (2) one traversing or contiguous to the territories of Nicaragua and Costa Rica; and (3) the long-time abandoned and newly re-animated Darien project. The author announces that the greater portion of his contribution will deal with the Panama enterprise, regarding which many fallacious ideas still prevail. (Ill.) 4 cols.—*Engineer*, Oct. 26th, 1900.

—— *The Elbe-Trave Canal.* By M. Georges Henry, Interesting description of the above-named canal, and of its details of construction and operation, the filling and emptying the sluices by syphons, and the manipulation of the gates by compressed air. (Ill.) 7 cols.—*Génie Civil*, Oct. 13th, 1900.

Docks.—*The Uraga Docks, Japan.* Description of a second set of docks as a branch establishment by the Ishikawajima Shipbuilding and Engineering Company, of Tokyo, at the entrance of the harbour of Uraga, in Tokyo Bay, now nearing completion. (Ill.) 1¼ col.—*Engineer*, Nov. 2nd, 1900.

—— *The new 750-ft. Dry Dock of the San Francisco Dry Dock Co., at Hunter's Point, Cal.* Description of a projected dry dock to be constructed by the San Francisco Dry Dock Co., at its yards, at Hunter's Point, San Francisco, California, which will be a notable addition to the dry dock facilities of the Pacific Coast. The new dock will be 750 ft. long, 122 ft. wide at the coping, and 74 ft. wide at the bottom, and will have a depth at the entrance of 32½ ft. below the coping, and 28th ft. below high-water level. (Ill.) 4½ cols.—*Engineering News*, Oct. 25th, 1900.

Jetties.—*Jetty Construction at Bilbao and Zeebrugge.* Digest of the official account of the works being carried out in the river for the improvement of the Port of Bilbao, and also of a paper presented at the International Navigation Congress at Paris by M. Pedro Garcia Faria. (Ill.) 1½ col.—*Engineer*, Nov. 2nd, 1900.

River Dams.—*Experiments on the Flow of Water over Dams.* Extracts from a report describing experiments with dam models representing the Lawrence dam, the Holyoke dam, and the Bear River dam, and also with a model of the latter in which the sharp-crested top was replaced with a round-off top. 4¼ cols.—*Engineering News*, Sept. 27th, 1900.

River Regulation.—*The Projected Improvement of the South-West Pass.* By William Starling, M.Am.Soc C.E., etc. The author, who is a member of the South-West Pass Board, appointed by the President of the United States, in conformity with a resolution of Congress in 1898, describes the project prepared by the first board, for the improvement of the South-West Pass of the Mississippi by a system of parallel jetties, extending from a point in the pass where the width was 2,700 ft. and preserving that distance to the crest of the bar and beyond to a depth of 30 ft., and the project also of a

second board, appointed March 3rd, 1899, which has recently presented its report. As their report is very concise the author gives a very full description of the reasons for adopting the particular project presented. (Ill.) 17⅞ cols.—*Engineering News*, Oct. 4th, 1900.

3. Irrigation.

4. Miscellaneous.

Boundary Surveys.—*The Survey of the United States and Mexican Boundary.* Digest of the report, recently published, of the American Commissioners appointed in 1891, in conformity with the Convention between the United States and Mexico, providing for a survey to re-locate the frontier line between the two countries. (Ill.)

ELECTRICAL ENGINEERING.

1. Electro-Chemistry.

Electro-Chemistry.—Summary of the papers read at the International Congress of Applied Chemistry at Paris. 1⅞ col.—*Electrical Review* (London), Oct. 19th, 1900.

2. Electric Lighting.

Electric Lighting.—*Liverpool Electric Lighting.* The article deals with some of the details of the new electric light stations recently put to work in Liverpool, one of them being situated at Sister Drive and the other at Pumpfields, in Vauxhall Road, the actual distance between the two being about 2½ miles, and between both the centre of Liverpool. (Ill.) 2½ cols.—*Electrical Engineer*, Oct. 19th, 1900.

—— *Progress in Electric Lamps.* By Prof. André Blondel. Abstract of a paper read before the International Congress of Electricity, in which the author passes in review the improvements realised up to the present, both as regards arc lamps and incandescent lamps. 4 cols.—*Electrician*, Nov. 2nd, 1900.

—— *The Nernst Lamp.* Description of this lamp in the new form in which it was exhibited at the Paris Exhibition, when the pavilion of the "Allgemeine Elektricitäts Gesellschaft" was lighted by 800 of these lamps, and gave a fine opportunity to compare their pure white light with other electric lamps. (Ill.) 1⅞ col.—*Electrical Review* (London), Oct. 12th, 1900.

—— *Nernst Lamps at the Paris Exhibition.* The article gives an appreciative description of the two different types of this lamp shown in the pavilion of the "Allgemeine Elektricitäts Gesellschaft." (Ill.) 1½ col.—*Western Electrician*, Sept. 22nd, 1900.

—— *Progress in Arc Lighting by Alternating Current Lamps.* By H. W. Hillman. Abstract of a paper read before the Ohio Electric Light Association, at Toledo, O., U.S.A., in which the author expresses his confidence in the future of arc lighting by alternating lamps, and refers to the very satisfactory result of trials made in Atlanta, Georgia, where, in consequence, the system has been adopted for street-lighting. (Ill.) 3 cols.—*Electrical Review* (London), Oct. 5th, 1900.

—— *The Electric Lighting of the City of Glasgow.* This is the concluding portion, and describes the engine-room, which contains dynamos from England, America and Germany, and engines from Scotland, England and America, in fact, as the author says, reminds one of an international exhibit; the condensing apparatus—of all the units except that of a marine engine previously described; the balancing and boosting sets, and the switch gear. (Ill.) 5 cols.—*Electrical Engineer*, Sept. 28th, 1900.

—— *Train Lighting from the Car-Axle.* Description of a new system, for which it is claimed that it combines features of merit of several of the older systems, its owners, the Consolidated Electric Lighting and Equipment Company of New York, having absorbed all of the various companies that for several years past have been engaged in bringing train-lighting from the car-axle to a point of perfection. (Ill.) 1⅞ col.—*Electrical Review*, (New York), Sept. 26th, 1900.

—— *The Electric Lighting of the City of Glasgow.* This article describes St. Andrew's Cross Station, the previous articles under the same heading referring to Port Dundas Station. This station, although officially opened on the same day as the former, is not quite finished as yet, and the article deals only with the machinery so far installed. (Ill.)—*Electrical Engineer*, Oct. 5th, 1900.

Electric Lighting.—*Electrical Illuminations for California's Semi-Centennial.* By O. F. Parker. Description of a very attractive display of electric lighting decorations at San Francisco on the occasion of the semi-centennial anniversary of California's admission to the Union. (Ill.) 1½ col. *Electrical Review* (New York), Oct. 3rd, 1900.

—— *Earthing Electric Light Mains.* Leader on the report of a committee of the National Electric Light Association recommending the earthing of the neutral wire of low tension, three-wire direct current systems on the ground that the risk of fire is greatly decreased. 1 col.—*Electrical Review* (London), Oct. 5th, 1900.

—— *Mistakes Made in the Rating of Incandescent Lamps.* By Prof. Arthur J. Rowland. Abstract of a paper read before the Franklin Institute, Philadelphia, U.S.A., in which the author draws attention to the ordinary methods of testing the candle-power of electric lights and the difficulties of obtaining a correct rating, after which he describes accurate means of measurement. 3 cols., 3½ cols., 1½ col. respectively.—*Electrical Review*, Sept. 26th, Oct. 10th, Oct. 17th, 1900.

3. Power.

Cost of Isolated Plants.—*The Steam-driven Isolated Plant—Does it Pay?* By W. S. Ennis. The author enters upon a comparison of the expenses of running isolated plants and plants that are supplied from central stations. 3 cols.—*Electrical World & Engineer*, Sept. 22nd, 1900.

Cost of Electrical Power.—*The Future of Electrical Power.* Abstract of a lecture by Professor S. P. Thompson, in which the author urges the substitution of large steam engines in place of the smaller ones, and shows the advantages of large central stations, in which coal is used as fuel. 1 col.—*Iron & Coal Trades Review*, Sept. 14th, 1900.

Dynamos.—*A Continuous-Current Dynamo for widely-varying Voltages, designed by E. Lanhoffer.* Slightly condensed translation from an article in *L'Electricien*, in which the above-named machine is described, for which the inventor claims great simplicity and at the same time posssessing the faculty of giving great variations of speed and voltages for continuous currents. 5 cols.—*Electrical Engineer*, Oct. 12th, 1900.

—— *Electrical Engineering at the Paris Exhibition. IV.* Description of dynamos for working searchlights and ordinary lighting on board ship, exhibited by the firm of Willen Smit & Co., of Slikkerveer, Holland. (Ill.) 1 col.—*Engineer*, Oct. 9th, 1900.

—— *The Dynamos of the Compagnie Internationale d'Electricité at the Paris Exhibition of* 1900. Description of the exhibits of the above-named company (H. Préper, Liège), *i.e.*, a unit of 1,000 kilo-watts consisting of a great three-phase current dynamo, yielding 1,000 kilo-watts at a tension of 2,200 volts; and a steam-engine built at the works of Van den Kerchove, of Ghent, running at the rate of 83 to 84 revolutions per minute. (Ill.) 1½ col.—*Revue Technique*, Oct. 10th, 1900.

Electric Plant.—*Buenos Ayres.* Digest of a long illustrated article describing in detail the Electricity Supply Works of the Compania General de la Ciudad at Buenos Ayres, the city receiving its supply from four stations, one of which, La Primitava, owes its existence to local enterprise; the second, the River Plate Electric Company, is of English origin; the third was founded by the Deutsche Ueberseeische Elektricitäts Gesellschaft as a branch of the Allgemeine Elektricitäts Gesellschaft of Berlin; while the fourth—described in this article—is that of the company above-named, which is a French concern, which entrusted the equipment to the Union Elektricitäts Gesellschaft of Berlin. 2 cols.—*Electrical Engineer*, Oct. 26th, 1900.

—— *The New Power Plant of the Massachusetts General Hospital.* Description of a plant designed for the purpose of furnishing current for lighting, together with a steam-heating and hot-water supply to a group of

hospital buildings. 2¾ cols.—*Engineering Record*, Sept. 1st, 1900.

Electric Plant.—*Electricity in an American Hotel.* Description of the fine electrical plant in the Raleigh Hotel at Washington, U.S.A. (Ill.) 2½ cols.—*Electrical Engineer*, Oct. 12th, 1900.

—— *The Electric Light and Power Plant of the Lachine Rapids Hydraulic and Land Company.* By Charles T. Child. Description of the above-named hydraulic and electric plant supplying 12,000 h.p. for various industries. 5 cols.—*Electrical World*, Sept. 12th, 1900.

—— *Bury St. Edmunds Electricity Works.* Description of this new plant, which promises to be very successful; the site being very central, the length of the feeders has to be but small. The chief drawback appears to be that coal has to be carted from the railway station, a distance of three-quarters of a mile, while the close proximity of the waterworks to the electricity works is an advantage, and it is probable that in the near future the pump in connection with the waterworks will be partly driven by electric motors. (Ill.) 5½ cols.—*Electrical Engineer*, Nov. 2nd, 1900.

Radiators.—*The Dowsing Electric Radiators.* Description of new and improved types of radiators, in which, since even the best reflectors absorb some heat vertical air passages are placed behind them and other improvements are introduced. ¾ col.—*Electrical Engineer*, Nov. 9th, 1900.

—— *The Paderno Electric Power Station.* Description of the power station, and its equipment, at Paderno, on the River Adda, the water power of which is transmitted to Milan, a distance of 32 kilometres, for the purpose of running the tramways and furnishing the light of that city. (Ill.) 1¾ col.—*Electrical Review* (London), Oct. 5th, 1900.

—— *The Electricity Works of Chèvres (Geneva).* Description of some of the difficulties overcome and the successes achieved in constructing these works, which serve the purpose of distributing electric energy for all purposes in the canton of Geneva. (Ill.) 4½ cols., 4¼ cols., 1¼ col. respectively.—*Electrical Review* (London), Oct. 12th, Oct. 26th, Nov. 2nd, 1900.

Power Distribution.—*Systems and Apparatus for Light and Power Distribution. II. Von Steinmetz Arrangement of High-Tension Circuits.* The author suggests methods with reference to the three usual systems of current distribution, *i.e.*, continuous-current three-wire system with 250 volts current between the outside conductors; alternating-current circuit with substations; arc-light circuit in series. 6 cols.—*Electrical World*, Oct. 20th, 1900.

Power Schemes.—*Electrical Development Schemes in India.* The article refers to the scheme to make use of the great force of the Jhelum River for the operation of an electric railway from Jumsan to Srinagar, a distance of 180 miles, and to the Simla water-power scheme, utilising the water of the Sutlej River for the operation of turbines for electrically working the Kranga Valley Railway, the North-Western Railway, and partly the Simla-Kalka Railway, certain power for lighting and other purposes being conveyed to Lahore and Simla; so far, however, practical operations have only been commenced upon one undertaking, *i.e.* that for which the Canvery Falls are to furnish the power and for which the large electrical machinery and equipment contracts are to be carried out by American electrical works. (Ill.) 4½ cols.—*Electrical Review* (London), Nov. 3rd, 1900.

Transformers.—*A New Constant-Potential Continuous-Current Transformer.* By E. W. Davies. The author gives a concise description of a simple method of compensating for the voltage drop in the secondary at full load, the method being analogous in its effect to the "compounding" of a dynamo; and the winding of the same, like the series winding of a compound dynamo, may be so proportioned that the secondary voltage at full load is either less or equal to, or greater than the voltage on open circuit, corresponding to the "under compounding" respectively of a dynamo. (Ill.) 2 cols.—*Electrical Review*, Oct. 19th, 1900.

Transmission Plants.—*Mr. Heather's Paper on Electric Transmission Plants at Moodie's Gold Mines.* By E. K. Scott. The author draws attention to the interesting information contained in the above-named paper, which gives the actual results of the working of two rival systems, viz., continuous current at 3,000 to 500 volts, supplied by the late firm of W. T. Gooden & Co., in 1893, and three-phase alternating current at 200 to 10,000 to 190 volts, supplied by the Allgemeine Elektricität Gesellschaft, through Reuert & Lenz, of Johannesburg, in 1896. Mr. Heather's paper is to be found in the official publication of the Institution of Civil Engineers (vol. cxli., p. 269). 2 cols.—*Electrical Review* (London), Oct. 5th, 1900.

4. Telegraphy and Telephony.

Cables.—*Some Interesting Faults met with in Cable Manufacture.* By J. Wright. The author, pointing out that a fault when correctly localised becomes a matter of interest, devotes his contribution to the description of faults of the kind indicated, and describes the many difficulties with which the manufacturer has to contend. 4 cols.—*Electrical Review* (London), Oct. 12th, 1900.

—— *Measurement of the Resistance of Cables.* By Arthur C. Heap. Description of the low-resistance potentio meter and of its employment, together with a set of standard resistances, a sensitive low-resistance D'Arsonval galvanometer, a secondary cell for maintaining a constant current in the slide wire, another for maintaining the constant current in the standard resisting circuit, a regulating resistance and ammeter for their circuit, and the measurements so obtained. 2½ cols.—*Electrical Review* (London), Oct. 5th, 1900.

Telegraphy.—*Recent Advances in Wireless Telegraphy.* This is a letter by Prof. Fleming to the *Times* in which he points out the achievements of Mr. Marconi and demonstrates their great practical value. 1 col.—*Electrical Engineer*, Oct. 25th, 1900.

—— *The Present State of Wireless Telegraphy.* Abstract of a paper by Prof. A. Blondel and Capt. G. Ferrie, read at the International Electricity Congress, at Paris. 1¾ col.—*Electrician*, Oct. 26th, 1900.

Telegraphone.—*The Poulson Telegraphone.* Reproduction of an article in the *Scientific American*, describing this apparatus in the form in which it was shown at the Paris Exhibition, and giving an account of the principle on which the invention is based. 2 cols.—*Electrical Review* (London), Oct. 12th, 1900.

5. Miscellaneous.

Alternators.—*The Synchronisation of Alternators Coupled in Parallel.* Condensed translation of the second and third parts of a paper entitled "A Study of the Transmission and Distribution of Energy by Alternation Currents," read at the meeting of the International Society of Electricians by M. Maurice Leblanc. 2½ cols., 1¾ col. respectively.—*Electrical Review*, Oct. 5th, Oct. 12th, 1900.

—— *The Accurate Measurement of Alternating and Multi-phase Currents.* By G. L. Addenbroke. Abstract of a paper read at the International Electricity Congress, at Paris. 3¾ cols.—*Electrician*, Oct. 5th, 1900.

—— *Three-Phase Alternator.* By Ganz & Co. Description of an alternator, giving 1,200 kilowatts at 2,200 volts, exhibited in the Hungarian section at the Paris Exhibition. ¼ col.—*Electrical Review*, Oct. 5th, 1900.

Cause of Electric Force.—*Some Remarks upon the Cause and Nature of the Electric Force.* By R. C. Shettle. The author endeavours to prove that matter is the result of cohesion, and that the portion of the medium which did not undergo condensation constitutes the ether and the seat of electric force. 4¾ cols.—*Electrical Engineer*, Aug. 24th, 1900.

Dangers of Electricity.—*Dangerous Electrical Pressures.* The article deals with a highly interesting investigation recently carried out by Prof. Weber, of the Zurich Polytechnic, on the physiological effect of alternating electric currents such as are used with overhead trolley wires. 1¼ col.—*Electrical Review* (London), Oct. 26th, 1900.

Dielectrics.—*Notes on Testing of Modern Dielectrics.* By J. Wright. 2 cols.—*Electrical Review*, Oct. 26th, 1900.

Dynamos.—*On the Construction of Dynamo-Electric Machines.* By Maurice Leblanc. Abstract of a paper read at the International Electricity Congress, at Paris. The author describes certain methods, by which he believes the magnetic leakage can be reduced to a minimum. (Ill.) 5½ cols.—*Electrician*, Oct. 12th, 1900.

—— *The Tendency of Modern Dynamo Design.* By William Cramp. The author refers to the abolition of many well-known forms of dynamos heretofore popular, and the almost universal adoption of a certain shape and frame intended for a certain output. (Ill.) 3 cols.—*Electrical Engineer*, Oct. 5th, 1900.

—— *The Philosophy of Dynamo Design.* The author, who states that the title of his contribution was suggested to him by Prof. Tilden's "Chemical Philosophy," confines himself to the case of continuous current machines, and dwells on the various points which a successful engineer must keep in mind. (Ill.) 3 cols., 5½ cols., 6½ cols., 6½ cols.—*Electrical Engineer*, Oct. 19th, Oct. 26th, Nov. 9th.

Dynamotors.—*Dynamotors v. Motor Generators.* By Alton D. Adams. The author endeavours to show that the former in many ways are superior to generators; the latter obtained their popularity on account of the difficulty experienced in regulating the secondary pressure in them. 3 cols.—*Electrical World & Engineer*, Sept. 8th, 1900.

Electrical Apparatus.—*New Apparatus introduced by the Helios Elektricitäts Aktien Gesellschaft, Köln Ehrenfeld.* Description of a new form of high-tension quick-break switch possessing distinct advantages over types hitherto constructed. (Ill.) 1¼ col.—*Electrical Engineer*, Oct. 12th, 1900.

Electrical Generators.—*Electrical Generating Set of 1,000 h.p.* By Ch. Parcey. Description of the horizontal Corliss engine of Escher, Wyss, & Co., of 1,000 h.p. and the Oerlikon electrical generator of 1,300 kilowatts at the Paris Exhibition. 1 col.—*Génie Civil*, Sept. 1st, 1900.

Electrical Heating.—*Electrical Heating for Buildings.* Description of cooking apparatus and heaters manufactured by the Prometheus Company of Berkenheim, near Frankfort-on-Maine, which has met with great success on the Continent, and in which electrical energy is converted into heat through resistances formed of thin films of precious metals, such as gold, platinum, etc., deposited on an insulating base of mica, enamel, or other suitable material, by which method resistances up to 25,000 ohms. can be obtained. (Ill.) 1¾ col.—*Electrical Engineer*, Oct. 26th, 1900.

Electro-Magnetism.—*Electro-magnetic Magnetism.* By Silvanus P. Thompson. Abstract of a paper read before the International Electric Congress at Paris, in which the author explains the principles of electro-magnetism and their connection with the chief classes of electro-magnetic mechanism. 3¾ cols.—*Electrical Review* (New York), Sept. 19th, 1900.

Inertia.—*On Some Methods of Determining Experimentally the Moments of Inertia of the Rotors of Dynamos and Alternators.* By Alfred Hay. This first instalment deals with the methods and means by which the moments of inertia may be experimentally determined. 2½ cols.—*Electrical Review* (London), Aug. 24th, 1900.

Lines of Force.—*Dust Figures of Electrostatic Lines of Force* By David Robertson. The author describes his apparatus for obtaining these figures and the figures themselves. 2½ cols.—*Electrical Review* (London), Sept. 7th, 1900.

Liquid Interrupters.—*Liquid Interrupters Connected in Parallel.* By E. Ruhmer. The author describes his experiments and the result obtained with a Wehnelt interrupter. 2½ cols.—*Elektrotechnische Zeitschrift*, Aug. 16th, 1900.

Measurements.—*Measurement of Alternating Currents by Current and Pressure Meters.* By E. Reisz. The author describes an improved method, in which two instruments are merely used. 1 col.—*Elektrotechnische Zeitschrift*, Aug. 23rd, 1900.

—— *Integrating Wattmeters and Ammeters* By Wm. Baxter, Jun. The author describes and explains various measuring instruments. 3½ cols.—*American Machinery*, Sept. 27th, 1900.

Metres.—*A Universal Carey-Foster Bridge.* By Charles V. Drysdale, B.Sc. The author points out that the Carey-Foster method of comparing resistances has long been known, and has been almost universally adopted for the standardization of coils of values from a tenth of an ohm upwards. Since, however, of recent years resistances of much lower values—down to one-ten-thousandth of an ohm—have been used, and as in his view the Carey-Foster method is by far the most accurate, he was led some years ago to extend this method for lower resistances by using the Kelvin double bridge, in a manner which he describes. (Ill.) 3¾ cols.—*Electrician*, Oct. 5th, 1900.

Periodicity.—*Periodicity in Alternating-Current Apparatus.* By James M. Andrews. Abstract of a paper read before the Ohio Electric Light Association, in which the author, refers separately to every periodicity, points out respectively their value as regards transformers, their influence upon line losses, induction motors, etc. 5 cols.—*Western Electrician*, Sept. 8th, 1900.

Quantities.—*On the Nature of the Electric and Magnetic Quantities.* By Reginald A. Tessenden. The author replies in this letter to a critic who disagreed with his system of "Qualitative Mathematics," and explains his view of natural phenomena. 1½ col.—*Electrical Review* (London), Sept. 14th, 1900.

Searchlights.—*The Big Searchlights at the Paris Exhibition.* Description of the searchlight on the tower of the German Navigation Section, manufactured by the Schukert Company, of Nuremberg, Germany, which was quite a feature, and of a very much larger searchlight of the same company. ⅞ col.—*Electrical Engineer*, Nov. 9th, 1900.

Stimulus.—*Electrical Stimulus—on the Similarity of Effect of Electrical on Unorganic and Living Substances.* By Prof. J. Chunder Bose. Abstract of a paper read before the British Association, in which the author explains molecular change upon electrical stimulus. (First Instalment.) 7 cols.—*Electrician.*, Sept. 14th, 1900.

Tractive Magnets.—*The Design of Tractive Electro-Magnets.* By Lamar Lynden. This is a letter explaining how the travel of a plunger can be lengthened by using conically-shaped pole-pieces. 1 col.—*Electrical World & Engineer*, Sept. 15th, 1900.

MARINE ENGINEERING AND SHIPBUILDING.

1. Merchant Vessels.

German Liner.—*Additional Particulars of the New Transatlantic Record Breaker "Deutschland."* The article gives detail dimensions of the machinery and contains various views of the hull while at the builders' yard, pointing out some peculiarities in the design that may be accounted for by the fact that the *Deutschland* was laid down with the view to service as an auxiliary cruiser in war time. (Ill.) 2½ cols.—*Marine Engineering*, Oct., 1900.

Merchant Vessels.—*The Merchant Marine at the Exhibition of 1900.* This contribution deals with the merchant marine of the various nations as represented at the Paris Exhibition, and the author points out that, although there has been no startling revolution in the building of merchant vessels during the last ten years, notable improvements in details have been made and some new types have made their appearance. 3½ cols., 5½ cols., and 5¾ cols. respectively.—*Le Yacht*, Oct. 20th, Oct. 27th, and Nov. 3rd, 1900.

Merchant Marine.—*German Merchant Marine at the Paris Exhibition.* Short account of the exhibits of the North German Lloyd, the Hamburg-American Line, and the firms of Blohm & Voss, F. Schichau, Vulcan, etc. (Ill.) 6¼ cols.—*Engineering*, Oct. 12th, 1900.

Schooners.—*Great American Schooners with Five and Six Masts.* By P. Amrel. The author, after referring to the fine merchant marine of the United States before the War of Secession, and its decline after the war, points out the recent revival and describes some of the latest vessels constructed, among them the *George*

W. Wells, recently launched by Capt. John G. Crowley, of Taunton, Massachusetts, a vessel carrying six masts, the largest ship of the kind ever constructed. (Ill.) 2¾ cols.—*Le Yacht*, Oct. 20th, 1900.

2. Pleasure Craft.

Yachts.—*Speed Trials of the New British Royal Yacht "Victoria and Albert."* The article gives an account of the dimensions of the vessel and the result of the trials; the author, however, hints that there is some reason for mistrusting the favourable reports circulated, and that the yacht will be tried on a trans-Atlantic trip before Royalty will embark on her. (Ill.) 1½ col.—*Marine Engineering*, Oct., 1900.

—— *The British Steam Yacht "Shamara,"* 588 *Tons.* Description of a yacht designed in 1899 by Messrs. Cox & King, naval architects, of London, and built the same year under their supervision in the shipyard of Messrs. Ramage & Ferguson, at Leith, being one of the finest and most elegant vessels of its tonnage. (Ill.) ⅝ col.—*Le Yacht*, Oct. 6th, 1900.

3. Equipment and Machinery.

Marine Engines.—*Balancing of Vertical Marine Engines Discussed in an Elementary Manner.* By J. Macfarlane Gray. This is the second chapter of the elementary introduction of a paper read before the Institute of Marine Engineers, London, in which the author, in a very lucid and simple manner, deals with this important subject. (Ill.) 2½ cols.—*Marine Engineering*, Oct., 1900.

—— *The Quadruple Expansion Engines of the Cunard Liner "Ivernia."* Description of the two engines which have four cylinders each of 711, 1,011, 1,486, and 2,134 mm. diameter respectively, and in common a stroke of 1,372 mm., and containing an account also of the boiler and auxiliary machines. 1 col.—*Engineering*, Oct. 5th, 1900, p. 436.

—— *The Turbine Engines of H.M.S. "Viper."* This is a description of the trials, together with explanatory comments on the subject by the inventor of the turbines, Mr. Charles A. Parsons. 2 cols.—*Steamship*, Nov., 1900.

Marine Filter.—*A New Marine Feed-Water Filter.* Description of a filter intended to prevent the action of the acids contained in the oils and the fatty matter which find their way into the boiler with the feed-water and are the main cause of the rapid internal deterioration of marine boilers. The makers of the filter are Messrs. John Broadfoot & Sons, Inchholm Works, Whiteinch, Glasgow. (Ill.) ¾ col.—*Steamship*, Oct., 1900.

Refrigeration.—*Refrigeration on Board Ship.* This is the first of a series of articles intended to illustrate from a practical standpoint, the chief principles underlying the action and functions of the various systems of refrigeration, and to give information of real value to those who have to superintend the actual working and the management of refrigerating machinery on board ship. (Ill.) 6 cols.—*Marine Engineer*, Nov., 1900.

Steering Gear.—*Steam Steering Gear of the SS. "Oceanic."* Description of the design of steering gear as fitted to the above-named vessel, recently built and launched by Messrs. Harland & Wolff, Belfast, being the largest steamship afloat. The apparatus is the result apparently of much thought; embodying, Hastie's steam steering, gear, Hastie's safety guide-frame, Hastie's patent rudder-brake, Hastie's patent radical worm-wheel, and Wilson & Pirrie's patent elastic steering quadrant; and is manufactured by Messrs. John Hastie & Co., Ltd., Kilblain Engine Works, Greenock. 1¼ col.—*Steamship*, Nov., 1900.

4. Docks.

5. Miscellaneous.

Buoys.—*Wighan Buoys with Mineral Oil Illumination.* Description of the difficulties of keeping the wick in order and how they are overcome in the above-named buoy by using an endless wick which at the point where the flame appears is carried over a roller, so that the flame constantly meets fresh portions of the wick. It is said that these buoys can be kept burning for a period of one to three months. (Ill.) ¼ col.—*Engineering*, Oct. 12th, 1900.

Fishing Vessels.—*Fishing Vessels at the International Exhibition.* Description of various kinds of fishing vessels, some of which were exhibited in the pavilions of the various countries on the Quai d'Orsay, others in the building specially devoted to forestry, hunting, fishing, etc., and still others in the Palace of Commercial Navigation. 2 cols. and 3¾ cols. respectively.—*Le Yacht*, Oct., 13th and 20th, 1900.

Lighthouses.— *Lighthouse Engineering at the Paris Exhibition, IV.* This article deals with the use of incandescent gas-light in lighthouses, the construction of burners of the Pintsch-Incandescent gas-light type; arrangement of focus and measurements of the lenses, when incandescent gas-light is used; the manufacture of the wick, the regulation of the supply of oil, where constant burners are employed. 2¾ cols.—*Engineer*, Oct. 12th.

Sailing.—*Is Training in Sailing Necessary in order to become a Mariner?* By Paul Amrel. The author, although fully realising the advantages secured by a practical education on a sailing vessel, and the opportunity it affords for developing courage and self-reliance, expresses himself in favour of a reduction of the time devoted to this branch of naval education, since sailing is becoming more and more obsolete, and making such instruction obligatory only for those who desire to join sailing vessels; while ordinarily it should be omitted, or maintained only as a kind of finishing education after completion of the regular training in the management of steamships. 3 cols.—*Le Yacht*, Oct. 13th, 1900.

Shipbuilding Tools.—*Machine Tools by Geo. Richards & Co., Ltd., Broadheath, Manchester.* The article describes various tools made by the above firm, some of them having been exhibited at Paris this summer. They comprise a side-planing machine; a slot-drilling and keyway-cutting machine; a patent universal facing and boring machine; a turret-head boring and turning machine; a side-planing and shaping machine; a patent scarping machine for ship plates; a standard type of horizontal boring machine. (Ill.) 3¼ cols.—*Steamship*, Oct., 1900.

—— *Arrol's Hydraulic Machine Tools in Shipbuilding Works.*—The article describes a hydraulic forging press; a hydraulic joggling press for the shell plates of ships; a hydraulic angle iron shears for cutting bars into short lengths; a pipe-flanging press, intended for forming flanges for ends of pipes and collars for surrounding them when they pass through water-tight divisions; and a hydraulic tube steering press; all constructd at the Dalmarnock Iron Works of Sir Wm. Arrol & Co., Ltd., in the East end of Glasgow. 1½ col.—*Marine Engineer*, Nov. 1st, 1900.

—— *Machine Tools for Shipbuilders and Engineers.* Description of a standard type of capstan lathe, especially designed for marine engine builders; a standard 30-in. swing lathe, for boring, surfacing, sliding, and screw-cutting, fitted with an improved 30-in. grab chuck; an improved shaping machine; a horizontal boring and tapping machine; a circular shearing machine, with circular cutter and 36-in. gap; a novel tube-screwing machine; and a wire-rope cutting machine; all constructed by Messrs. Dron & Lawson, tool makers, Cranstonhil, Glasgow. (Ill.) 2½ cols.—*Steamship*, Oct., 1900.

—— *Shipyard Tools by Bertrams, Ltd., Edinburgh.* Description of a double-ended punching and shearing machine for punching holes 1¼ in. diameter through steel plates 1¼ in. thick and for shearing plates up to 1½ in.; a cam-lever punching and shearing machine; a set of plate-bending rolls; a beam and angle bending and straightening machine; a plate straightening machine of improved design; a self-acting plate-planing machine of new design; a circular cutting machine, specially designed for dealing with thin tank and other plates; and a specially designed elliptical lathe, suitable for turning, boring, facing, and cutting out ellipses. (Ill.) 2½ cols.—*Steamship*, Oct., 1900.

Submarine Boats.—*Submarine Boats, from the Earliest Records down to the Present, I.* By Karl Busley. The article is a translation from the Proceedings of the German Society of Naval Engineers. The author gives a description of the most interesting models constructed, and states that in his search among

the German archives he has discovered not less than 181 different designs of submarine boats submitted to the naval authorities since 1861 by designers belonging to all branches of business except that of ship construction. (Ill.) 5¾ cols.—*Marine Engineering*, Oct., 1900.

MECHANICAL ENGINEERING.

1. Boilers, Furnaces, and Fuel.

Boilers.—*A Steam Boiler as a Calorimeter.* Description of an unusually elaborate boiler trial undertaken to determine the heating value of coal under the conditions of its use in boilers; the work carried out at the Stevens Institute consisted of a series of experiments with a boiler used virtually as a calorimeter, and was of considerable interest, aside from the main object, on account of the accurate modes of measuring employed. 2 cols.—*Engineering Record*, Oct. 6th, 1900.

—— *Boiler Explosions.* By William H. Lowler, Wh.Sc., M.Inst.C.E., etc. This is a digest of the Board of Trade Reports, and deals with the failure of a brazed copper steam-pipe on board the s.s. *Adriatic* while in the North Sea; a series of vertical boiler failures; the collapse of a weak flue tube; the failure of a smoke tube in a locomotive boiler, occurring at Northwich; the failure of a cast-iron steam receiver of the engines on board the s.s. *Specialist* while in the Bay of Teneriffe; and the failure of a seamless copper steam-pipe made by the Elmore Copper Depositing Company. (Ill.) 4¾ cols.—*Mechanical Engineer*, Oct. 6th, 1900.

—— *Care of Boilers on Board Ship.* Comments on the revelations made in the course of a Board of Trade Inquiry. held at Liverpool in October last, respecting the failure of the main boilers on board the Isle of Man passenger steamer *Ireland*, on July 26th, during the course of a passage from Liverpool to Douglas, which disclosed a very deplorable state of things. 1 col.—*Mechanical Engineer*, Oct. 27th, 1900.

—— *Low-Pressure Steam and Hot-Water Boilers.* Description of a great variety of types and sizes of boilers constructed by Messrs. Hartley & Sugden, Ltd., of Halifax, for the requirements of low-pressure hot-water or steam heating, the principal features being slow combustion and economy of fuel. (Ill.) 1½ col.—*Mechanical Engineer*, Nov. 3rd, 1900.

—— *Water-tube Boiler—Joya System.* Description of a water-tube boiler, exhibited at the Paris Exhibition by Messrs. Joya & Co., Grenoble, France, which shows many novel and interesting improvements. (Ill.) 1½ col. —*Revue Technique*, Oct. 10th, 1900.

Valves.—*Improved Reducing Valve.* Description of a reducing valve, constructed by the British Steam Specialities, Ltd., Fleet Street, London, constructed especially for all vacuum, atmospheric and very low pressure systems, such as are now being used in many buildings for heating purposes. (Ill.) 1 col.—*Mechanical Progress*, Oct., 1900.

Fuel.—*Liquid Fuel.* Reproduction of a paragraph in the *Journal of the Society of Arts*, in which is given a translation of part of an article by M. H. Guérin in the *Génie Civil* of May last, stating the proportions of carbon, hydrogen and oxygen in various hydro-carbons and their calorific power, which are of great interest in connection with the use of liquid fuel, which is becoming more common, especially in war-vessels. ⅝ col.—*Engineer*, Oct. 12th, 1900.

Stoker.—*The American Under-feed Stoker.* Description of a mechanical stoker of the under-feed type, now being introduced by the Under-feed Stoker Company, Ltd., of 31, Walbrook, E.C., suitable for all kinds of coal, from fine slack to good steam coal, any large lumps in the latter being broken by teeth at the outlet from the hopper; cleaning is rarely required, it being only necessary to remove the clinker every seven to 12 hours. (Ill.) ½ col.—*Engineering*, Oct. 26, 1900.

2. Compressed Air.

Compressed Air.—*Experiments on the Re-heating of Compressed Air.* By Wm. George Walker, A.M.I.C.E. The author points out the economy that can be obtained by re-heating compressed air before admitting it to the engines, and the best methods of accomplishing this. (Ill.) 1¾ col.—*Mechanical Engineer*, Oct. 20th, 1900.

Compressed Air.—*Regulating Device for Air-Compressing Engines.* Description of a device successfully employed by Messrs. Lancaster & Tonge, a well-known engineering firm, with a speciality of making pistons, valves, metallic packing, etc., having works at Pendleton, Manchester. The device described is intended for engines working air-compressors, more especially in connection with collieries, where sudden and large demands are sometimes made upon the air-receiver. (Ill.) ⅝ col.—*Mechanical Engineer*, Sept. 29th, 1900.

3. Engines and Motors.

Automobiles.—*The "Orfray" Motor Car.*—Description of a vehicle containing various interesting features, among them the use of a large cylinder motor, placed horizontally and out of centre with the frame. The fact that the friction clutches, which are employed for locking either of the four gear-wheels, give three forward and one reverse speed to the engine shaft, and finally the compact arrangement of the mechanism and its attachment to the frame. (Ill.) ⅞ col.—*Automotor*, Sept. 1900.

—— *The Joel Electric Car.* Full description of an electrically-propelled vehicle which has recently made a successful run from London to Brighton without recharging, and represents the latest development of Mr. Joel's inventions. The car is of the voiturette type, with room to seat comfortably two passengers. (Ill.) 2⅝ cols.—*Automotor*, Oct. 1900.

—— *The Paris Exhibition.* Concise description of the more important automobile exhibits, classified as follows: The larger French cars, the French voiturettes, the French military vehicles, the electric vehicles of all nations, etc., irrespective of their official classification or of the positions in which they are found. English vehicles were entirely absent, except one Australian automotor exhibited by Mr. Thompson, of Melbourne. 22 cols., accompanied by illustrations covering altogether about 10 double-column pages.—*Automotor*, Oct. 1900.

—— *The Siemens and Halske Electric Tram Omnibus.* Description of a very original and interesting vehicle, having, among other novel features, two guide-wheels in front of the ordinary wheels, and being provided with a trolley, so as to enable it to run in the suburbs in which trolley lines exist on tramway rails and to take current from the overhead conductors, while within the radius of heavy traffic it runs as an automobile independent of rails and of current supply from outside, drawing its motive power from the accumulators contained in it. (Ill.) 1½ col.—*Automotor*, Sept., 1900.

—— *The Duryea Three-Wheeled Motor Car.* Description of a vehicle, built by the Duryea Power Company of America, in which the two rear wheels are used for driving the car, while the third steering wheel is placed in front. A special feature is the method used for mounting this front wheel, a stationary-supporting spring passing completely through its centre. The car weighs about 650 lbs., and the wheels are 36 and 30 ins. in diameter. (Ill.) ⅝ col.—*Automotor*, Sept., 1900.

Engines.—*The 3,000-Horse-power Engines of the Luisenstrasse Central Station, Berlin.* Abstract of an article published some months ago in the *Ztschrft. d. Ver Deutsch. Ing.*, describing these 3,000-h.p. triple-expansion engines with two cranks on the main shaft, then in operation at the Luisenstrasse Central Station Electrical Works. (Ill.) 3¾ cols.—*Engineering Record*, Oct. 13th, 1900.

—— *A Method of Ascertaining the Degree of Irregularity in Rotary Engines.* By Dr. F. Göpel. This is a communication furnished by the Physico-Technical Imperial Institute. The tests were undertaken at the request of the Society of German Engineers, submitted to the Institute in 1894, it being pointed out that a means of accurately determining such irregularities would be of the greatest value to the technical world, especially since the high demand made upon steam-engine builders by the progress of Electricity. 9 cols. and 13 cols. respectively. —*Zeitschrft. d. Ver. Deutsch. Ing.*, Oct. 6th and 20th, 1900.

Turbines.—*The Construction of Turbines.* By Prof. E. Reichel, Charlottenburg. (Continued.) The present instalment deals with the exhibits, at Paris, of Messrs. Ganz & Co., of Budapest, consisting of a large turbine of

1,000 h.p. and a smaller one. The former is of the type used in the electrical works for calcium carbide manufacture at Jajce, in Bosnia. The article describes this interesting plant. (Ill.) 3½ cols.—*Zeitschrft. d. Ver. Deutsch. Ing.*, Oct. 6th, 1900.

4. Power and Transmission.

Power Transmission.—*Transmission of Power by Quick-running Belts.* By M. Gehrkens. Report of paper read at the Hamburg Branch of the Society of German Engineers, in which the author communicates very interesting results regarding the durability and efficiency of belting. 4 cols.—*Zeitschrft. d. Ver. Deutsch. Ing.*, Nov. 3rd, 1900.

Pulleys.—*A Remarkable Test of a Wooden-Rim Pulley.* This is a description of certain tests to which a wooden-rim pulley has been subjected and their results. Some time ago the Dodge Manufacturing Company, of Mishawaka, Ind., U.S.A., received an order for an iron centre wood-rim pulley, 46½ ins. in diameter and 16 ins. on the face, for a 4-in. shaft. It was to be tested to a rim speed of 9,000 ft. per minute. It occurred to the makers to ascertain, if possible, the maximum rim-speed at which such a pulley could be operated, and the tests showed that it could be run at a speed of 28,889 ft. per minute. (Ill.) 1½ col.—*Engineering Record*, Oct. 13th, 1900.

5. Machine Works, Shops and Foundry.

Machine Shops.—*The Shops and Manufactures of the Hendry Machine Company.* Description of the well-equipped shops at Torrington, Conn., a town on the Nangatuck River, in a picturesque, but somewhat isolated position; the business of the company consists entirely in the manufacture and sale of the Hendry shapers and the Hendry-Norton lathes. (Ill.) 8 cols.—*American Machinery*, Oct., 1900.

Workshops.—*An Englishman's Impressions of a German Workshop.* By F. Brocklehurst, M.A. The author describes a visit to the well-known machine shops of Messrs. Loewe & Co., at Berlin, and describes the excellent sanitary arrangements and the pains taken to insure the comfort of the 1,200 workmen employed by the firm.

6. Tools.

Machine Tools.—*New Bliss Perforating Press.* Description of a machine recently completed by the E. W. Bliss Company, 24, Adam Street, Brooklyn, N.Y. The casting of this press alone weighs something like 15 tons, and is claimed to be one of the largest castings ever turned out in Greater New York.

7. Refrigeration and Cold Storage.

Refrigeration.—*Dr. C. Von Linde's Liquid Air Apparatus at the Paris Exhibition.* By M. A. Desvignes. The author explains the principles on which Dr. von Linde's apparatus is based, describes its construction and working, and draws attention to the ridiculous and fraudulent representation of some of the American company promoters. 2 cols.—*Cold Storage*, Oct. 15th, 1900.

Refrigerating Plant.—*The Birmingham Cold Storage, Ltd.* Description of a plant entirely devoted to the cold storage of hops, having a greater capacity for such goods than any other in the country, and being the largest of any kind driven by electricity. (Ill.) 3⅜ cols.—*Ice & Cold Storage*, Nov., 1900.

—— *Mr. John Palmer's Meat-Chilling Rooms and Stores.* Description of a very complete and up-to-date refrigerating plant not far from the London Central Markets, the refrigerating space, in all, amounting to about 64,000 cub. ft. (Ill.) 1¼ col.—*Ice & Cold Storage*, Nov., 1900.

8. Miscellaneous.

Condensers.—*Centralisation of the Steam-Condensing Plant.* By H. G. V. Oldham. This is the first portion of a serial describing modern cooling towers, evaporative condensers, and the equipment of central condensing plant. 7½ cols.—*Engineering Magazine*, Oct., 1900.

Cooling Towers.—*A Cooling Tower Operation with Natural Draft.* Description of a cooling tower, built by the Wheeler Condenser and Engineering Co., intended to cool water from 135 deg to 85 deg. or 90 deg. Fahr. 1 col.—*Engineering News*, Sept. 27th, 1900.

Machine Shops.—*Commercial Organisation of the Machine Shop.* By Hugo Diemer. Concluding portion of a serial on the subject. The author concludes his remarks on the production department and deals with the importance of accurate time-keeping. 5⅝ cols. *Engineering Magazine*, Oct., 1900.

Screw Making.—*A Communication dealing with the Computation of Screw-threads.* By H. Camerer. The author explains the methods of computation and publishes diagrams indicating the various stresses and formulas for computation; the influence of torsion is also taken into consideration. 2 cols.—*Zeitschrft. d. Ver. Deutsch., Ing.*, Aug. 11th, 1900.

MINING AND METALLURGY.

1. Coal and Coke.

Coal Supply.—*The World's Need of Coal and the United States' Supplies.* By F. E. Saward. The author refers to the noteworthy alterations in the coal supply of the world, and to the large treasures of coal in the United States. 7 cols.—*Engineering Magazine*, Oct. 1900.

Coking Coal Field.—*A New Coking Coal Field.* By Wm. Gilbert Irwin. The author points out that there are great prospects for profitable coal-mining in the district between Clarksburg and Fairmont, in Richie County, West Virginia, U.S.A., lying within one of the most remarkable coal seams in the United States. The Briar Hill Coke and Coal Company, the Riverdale Coke Company, Solon & Lowry, and a dozen others have already entered this field, but its development is just beginning. ½ col.—*Engineering & Mining Journal*, Oct. 12th, 1900.

2. Copper.

Copper Assaying.—*The Calorimetric Assay of Copper.* By J. D. Audley Smith. Abstract of a paper read before the Canadian Meeting of the American Institute of Mining Engineers, describing a series of standard colours for every batch of assays in the Heine "blue test" for copper. 2 cols.—*Engineering & Mining Journal*, Sept. 15th, 1900.

Copper Mining.—*Mining Practice in Butte, Montana, Copper Mines.* By R. B. Brinsmade, B.S., E.M. The author deals with shaft-sinking and costs, methods of timbering, blasting, drifting, stoping, and raising; hand-drilling, machine-drilling, transmission, haulage, ventilation, etc. (Ill.) 5½ cols.—*Mines & Minerals*, Oct. 1900.

—— *Copper Mining in Northern Wisconsin.* By Kirby Thomas. Abstract of a paper read before the International Mining Congress at Milwaukee, Wis., June 22nd, 1900, dealing with the geology, discoveries, and development in the Western Lake Superior region. 2 cols.—*Mines & Minerals*, Oct. 1900.

3. Gold and Silver.

Gold Mining.—*Gold Dredging on Snake River, in Idaho.* By F. Powell. The author compares the history of gold dredging on Snake river with that of early dredging in New Zealand. The general conditions seemed to be very favourable for profitable dredging, but the result has been otherwise. The cause is to be found, according to the author—first, in the fact that in most cases the pay is confined to a few inches of gravel at the surface of the bar, and, since it is necessary in dredging to excavate to a depth of at least 4 ft. below water-level, it follows that a good many yards of barren material must be handled. A second drawback is the circumstance that the gold is very fine, averaging about 1,000 colours to the cent, and always associated with magnetic iron sand, from which it is separated with difficulty. 2 cols.—*Engineering & Mining Journal*, Oct. 6th, 1900.

4. Iron and Steel.

Furnace Gas.—*The Blast Furnace as a Power Producer.* Description of the Thwaite-Gardner system of

utilising blast furnaces in gas engines. 1½ col.—*Iron & Steel Trades Journal*, Sept. 15th, 1900.

5. Mining and Mining Methods.

Placer Mining Methods.—*Exploiting a New Placer Field.* The author points out various considerations to be taken account of in opening a new placer-mining field, and illustrates his suggestions by experiences he met with in placer mining at Fairplay, near Alma, Colorado. 3 cols.—*Mines & Minerals*, Oct., 1900.

Timbering Methods.—*Methods of Shaft Timbering.* The author refers in detail to the various points to be kept in mind, such as timbering in water and quicksand; swinging of the shaft curbing; the framing of shaft timbers; the thickness of shaft curbing. 2¼ cols.—*Mines & Minerals*, Oct., 1900.

MUNICIPAL ENGINEERING.

1. Gas Supply.

Coal Gas.—*The Heating and Lighting Power of Coal Gas.* By T. Fairbey. Abstract of a paper read before the Bristol Association, demonstrating the connection between the heating and lighting power of coal gas. 2¼ cols.—*Journal of Gas Lighting*, Sept. 18th, 1900.

Gas Industry.—*The Gas Industry of the Exposition of* 1900. By J. Leroy, in *La Nature*. Description of the work undertaken by the Compagnie Parisienne du Gas and its exhibits. 2¼ cols.—*Scientific American Supplement*, Sept. 15th, 1900.

Gas Lighting.—*Incandescent Gas Lighting.* By Dr. H. Bunte. Abstract of a paper read before the International Gas Congress at Paris, pointing out the effect of the invention of the Welsbach light upon the quality of gas produced, and giving the results of photometric tests undertaken to show the illuminating effect of Welsbach mantles. 7 cols.—*Journal of Gas Lighting*, Sept. 22nd, 1900.

Gas Mains.—*Laying a 24-in. Gas Main across the Harlem River.* By G. N. P. McVey. Account of the work of connecting the Manhattan and the Bronx, New York. 1½ col.—*Scientific American*, Sept. 15th, 1900.

Gas Works.—*The Alkali Works Report.* By Harold G. Colman. These are extracts from the above-named report of a special interest to gas manufacturers, including an account of the desulphurising of gas liquor. 8 cols.—*Gas World*, Sept. 1st, 1900.

—— *Abstract of the Report of the Chief Inspector under the Alkali Act*, referring to the constitution and analysis of ammoniacal liquor, the results of an analysis undertaken with the object of ascertaining the constituents. 9 cols.—*Journal of Gas Lighting*, Sept. 11th, 1900.

—— *Waverley Association of Gas Managers—Half-yearly Meeting at Dalkeith.* Address of the President, Mr. W. McGiffen, referring to the most efficient working of the retort-house. 8 cols.—*Journal of Gas Lighting*, Sept. 18th, 1900.

—— *The Absorption of Hydrocyanic Acid from Illuminating Gas.* By Dr. A. Smits. Abstract of a paper read before the International Gas Congress at Paris, referring to the production of yellow prussiate or ferrocyanide of potash by the wet process. 1½ col.—*Journal of Gas Lighting*, Sept. 18th, 1900.

2. Sewerage.

Sewerage.—*The Leeds Sewage Disposal Experiments.*—Abstract of a report on the progress of the work, issued by the Sewage Committee, dealing with tests of various systems and comparing their efficiency. 2½ cols.—*Engineering Record*, Sept. 22nd, 1900.

—— *Sewage Purification by the Ridgeway Automatic Sewage Distributor.* — Description of a mechanical distributor for the intermittent feeding of any description of filter beds, etc., or in measured quantities and at definitely fixed intervals; the distributor has been built by Messrs. Mather & Platt of the Salford Iron Works. 1½ col.—*Public Health Engineer*, Oct. 6th, 1900.

3. Streets and Pavements.

Street Paving.—*The Construction of Standard Medina Block Stone Pavements.* E. A. Fischer. Abstract of a paper read before the meeting of the American Society of Municipal Improvements at their Milwaukee Meeting, in which the author describes the methods of construction used in Rochester, N.Y. 7½ cols.—*Engineering Record*, Sept. 15th, 1900.

4. Water Supply.

Water Analysis.—*Water and Sanitary Affairs.* Editorial dealing with the report of Dr. T. E. Thorpe, sent to the Registrar-General, setting forth the result of his chemical analysis of the water supplied to the metropolis, and pointing out the improvements introduced in order to enhance the value of such analysis. 1½ col.—*Journal of Gas Lighting*, Oct. 16th, 1900.

Water Supply.—Comments on the reports of the Local Government Board recording the work of the two officials appointed under the Metropolis Water Act, 1871—the Auditor and the Water Examiner—who on behalf of the public watch the work of the water companies. Editorial. 2 cols.—*Journal of Gas Lighting.*, Nov., 1900.

Waterworks.—*Screens and Screen Lifters: Metropolitan Waterworks.* Boston and vicinity. By Chas. W. Sherman. The article deals with a screen of standard type, and describes a mechanical device for manipulating it. ¾ col.—*Engineering News*, Sept. 17th, 1900.

—— *Repairing a Submerged Water Main.* Description of a method used in Cleveland, O., U.S.A., for patching riveted steel mains injured by anchors. ¾ col.—*Engineering Record*, Sept. 22nd, 1900.

5. Miscellaneous.

Municipal Improvements.—*The Convention of the American Society of Improvements.* This is a digest of the report dealing with methods of classifying and preparing municipal statistics, with cement testing for small towns, and with methods of paving. (To be continued.) 5 cols.—*Engineering Record*, Sept. 8th, 1900.

NAVAL AND MILITARY.

1. War Vessels.

Battleships. — *The Damage to the "Oregon."* Account of the damage done to the vessel when it grounded on a submerged rock in Chinese waters. ¾ col.—*Scientific American*, Sept. 29th, 1900.

Torpedo Boats.—*Torpedo Craft—United States and Foreign—Types and Employment.* By R. N. Jackson. Digest of a prize essay read before the U.S. Naval Institute at Annapolis, Ind. First instalment of a serial. 2¾ cols.—*Marine Engineering*, Sept., 1900.

Moulding.—*The Problem of Machine Moulding.* By E. H. Mumford. A paper submitted to the meeting of the Foundrymen's Association, in which the author points out the advantages of machine moulding, and describes the best employment of moulding machines. 2¾ cols.—*Foundry*, Sept. 6th, 1900.

2. Equipment.

3. Armour Plates, Guns and Ammunition.

4. Miscellaneous.

Binoculars.—*Sundries.* Under this title the magazine below mentioned publishes various items of interest to army officers, and among them a translation of a description of a new and improved binocular for field service, published in the *Kriegstechnische Zeitschrift.* This binocular is the *Goerz-Trieder* binocular, of a greatly improved kind, embodying the advantages of a telescope with a comparatively short tube, and distinguished by high light, intensity, and amplification, which confer on it a great space penetrating power, combined with a much wider field of view than was obtainable in the older forms (Ill.) 1½ p.—*United Service Magazine*, Sept., 1900.

Field Engineering.—*Field Engineering for Home Defence.* By Captain R. F. Sorsbie, R.E. Part I. The author endeavours to bring home to officers of Volunteer Infantry the need for training themselves in the engineering duties which would inevitably fall to their lot in the field, for which purpose he limits his remarks to the requirements of home defence. 6½ pp. and 3¾ pp.—*United Service Magazine*, Oct. and Nov., 1900.

RAILWAY WORK.

1. Motive Power and Equipment.

Locomotives. — *Six-Coupled Passenger Engines.* Description of a powerful passenger locomotive of the ten-wheeled type, having six-wheels-coupled and a four-wheeled bogie in front, six of which have recently been added to the rolling stock of the Highland Railway Company. (Ill.) 3 cols.—*Railway Engineer*, Nov., 1900.

—— *At the Paris Exposition. British Locomotives Exhibited by Four Great English Railway Companies.* The article deals with the exhibits of the London and North Western Railway, the Midland Railway, the Great Eastern Railway, and the North Eastern Railway, and an engine built in Belgium for the Barry Railway of South Wales. 3⅜ cols. *Railway Age*, Oct. 12th, 1900.

—— *German, Austrian, French, and Swiss Locomotives. Something about Wheels.* The author, after a little banter with reference to the conspicuous advertisement of "Griffin" wheels, while the great number of types of other wheels remain "un-named and unsung," continues his description of the continental locomotives, first dealing with the nine locomotives of German make. Among these a 7-cylinder compound 8-wheeled express, built at the Hanoverian Engine-building Company's Works, is treated somewhat in detail, owing to its novel features and the fact that it obtained a *grand prix*; another engine, built by Krauss & Co., of Munich, is said to be one of the most remarkable at the show. He then passes in review the Austro-Hungarian exhibit, which is very extensive. Among the French engines, one built by Messrs. Schneider & Co., of the Creusot Works, a locomotive of very large size, receives special notice. The article concludes with a description of the Swiss exhibit, notably a neat little narrow-gauge engine, built for service in Africa, by the Société Suisse, at Winterthur. 8½ cols. —*Railway Age*, Oct. 26th, 1900.

—— *Locomotives Exhibited in the Italian and Russian Sections.*—Description of the two locomotives built in Italy, both notable in their way. The one is especially interesting on account of the fact that it was built to run cab first, as the illustration in the text shows, and has other peculiar features; but appears to be of great efficiency, and the Italian Adriatic Railway which exhibited it obtained for it the great prize. The other engine, the "Allessandro Volta," exhibited by the Mediterranean Railway, is a powerful locomotive weighing 55 tons empty. The Russian locomotives which are dealt with in the same article, while not as large as the French, nor having among them such a curiosity as the one Italian engine, are said to be, by the writer, the most interesting display of locomotives and rolling stock at the Exhibition. 3⅜ cols.—*Railway Age*, Oct. 9th, 1900.

—— *Early Locomotive building in Massachusetts.*— By Herman L. Morn. The author first deals with the early work of the Essex Machine Shop, of Lawrence, Mass., U.S.A., describing the work in this shop of the Essex Company, to which the city of Lawrence practically owes its existence, and then reviews the work carried on at the Globe Works in South Boston, in which locomotives were built previous to 1850. 5½ cols.—*Locomotive Engineering*, Sept., 1900.

2. New Projects and Lines in Construction.

French Projects.—*Railway Construction in French Indo-China.*—The article reviews various projects of railway construction in Indo-China and Southern China. 1 col.—*Engineering*, Sept. 14th, 1900.

—— *Six Months of Railroad Building in 1900.*— This is a review giving details of lines projected and sections completed in the United States, classified with reference to states and territories. 2 cols.—*Railroad Gazette*, Aug. 31st, 1900.

3. Permanent Way and Fixtures.

Cementing Gravel.—*On the Structure of Cementing Gravel.* By Geo. R. Wieland. The author describes the conditions under which ballasting material, such as cementing gravel, hardens into rock. ⅝ col.—*Railway & Engineering Review*, Sept. 15th, 1900.

STREET RAILWAYS AND TRAMWAYS.

1. Trolley Lines.

Trolley Lines.—*The City of Carlisle Electric Tramways.*—Description of this system, which was practically completed at the end of July last, from specifications of Messrs. Alfred Dickinson & Co., Birmingham. 4⅛ cols.— *Tramway & Railway World*, Oct. 9th, 1900.

2. Surface Contact Lines.

Surface Contact Line.—*International Tramways Congress. The Dialto System.* Portion of the report dealing with the Dialto system. Description of a not yet completed line on the left bank of the Seine, where this system is being installed. 1 col.—*Tramway & Railway World*, Oct. 11th, 1900.

3. Miscellaneous.

Electric Tramways.—*Effect of Introducing Electricity on Tramways.* By E. von Pirch. Abstract of a paper read before the International Tramway Congress at Paris, in which the author dwells on the advantages obtained by the use of electricity for the facilitation of traffic, reduction of expenditure, increase of income, etc., adding that steeper gradients can be used, longer cars employed, etc., and many drawbacks to local traffic removed. 1 col.—*Street Railway Journal*, Nov. 1900.

Electric Railways.—*The Paris Metropolitan Railway.* Description of this very important line, the main line of which, for the present, extends 6⅜ miles, right across Paris, from the Porte Maillot to the Porte Vincennes, while the two branches under construction from the Arc de Triomphe extend to the Porte Dauphine, 0·9 mile, and to the Trocadéro, 0·75 mile. The lines, like the London electric railways, are worked on the third-rail system, the return current being taken by the track rails, which are electrically connected at the joints by four copper bonds. 6⅜ cols.—*Tramway & Railway World*, Oct. 11th, 1900.

Engines. — *Engines for Electric Traction.* — *II.* Description of vertical engine direct-coupled to generator, by Messrs. Mather & Platt, of Manchester; an enclosed type of compound vertical engine, by Robey & Co., of Lincoln; and a vertical compound tandem engine, by Messrs. Pollet & Wigzell. (Ill.) 4 cols.—*Tramway & Railway World*, Oct. 11th, 1900.

Power Distribution.—*Power Distribution on Electric Railways.* By M. Van Vecter, electrical engineer at Brussels. Abstract of a paper read before the International Tramway Congress at Paris, in which the author discusses distribution by means of continuous current, alternating current, and a combination of both systems. Continuous current, he remarks, is the simplest method for short lines; for longer lines alternating current is frequently more economical. The article is accompanied by tables comparing first cost and cost of maintenance for the different systems. 1⅜ col.—*Street Railway Journal*, Nov. 1900.

TRADE AND ECONOMICS.

1. Commerce and Trade.

Coal Ports. — *The Resources, Equipment, and Growth of British Coal Ports.—II. Blyth.* This is the first of a series of articles in which this new publication intends to give a short description of the various British coal ports, their resources and facilities. Blyth, as the most northern of the important British coal ports, is selected for the opening article. 2¼ cols. — *The Coal Merchant & Shipper*, Sept. 26th, 1900.

Coal Trade.—*The Coal Exchanges of Great Britain.* The article gives a concise description of the leading coal and iron exchanges in the United Kingdom and the amount of business done, giving their principal characteristics and distinguishing features, etc., together with illustrations of the buildings. 3½ cols.—*Coal Merchant & Shipper*, Sept. 29th, 1900.

REVIEWS.

The Principles of Mechanics. By H. Hertz. Translated from the German by D. E. Jones, B.Sc., and J. T. Walley, M.A. Macmillan & Co. Pp. xxviii. and 276.

The German treatise of which this is a translation formed the work of the last three years of Hertz's life, and was published after his death under the supervision of Professor Lenard, who has also assisted the translators with their work. We must congratulate both Professor Lenard and the translators on the manner in which they have carried out what must have been an exceedingly difficult undertaking. The book reads almost throughout as though it had been originally written in English. In some few cases, where the meaning appeared somewhat obscure, reference to the German original led us to the conclusion that it would be impossible to give a better rendering of passages which offered exceptional difficulties to the translator.

Although, unfortunately for science, Hertz died before he had completed his thirty-seventh year, he had already obtained from his researches on electric waves a world-wide reputation, both as an experimentalist of the very highest class and as an acute reasoner.

The work now under consideration is one of the most important systematic contributions to theoretical physics which has appeared in recent years, and would, if it stood alone, place its author in the very front rank of mathematical thinkers.

As the author points out in his preface, it is agreed that the problem of physics consists in tracing the phenomena of nature back to the simple laws of mechanics, but as to what these simple laws are there is not the same consensus of agreement.

What is known as the science of mechanics, or dynamics, originated in investigations of the conditions of equilibrium and of the motions of bodies directly connected with one another in such simple cases as levers, inclined planes, systems of pulleys, etc., and the earliest general solution which was given of problems arising in this way was what was known as the law of virtual velocities. After this followed Galileo's discovery of the principles of inertia and acceleration, and then Newton's formulation of those laws of motion which have been universally accepted as forming the groundwork of mechanics.

Newton's laws were based on the assumption that the forces to be considered consisted entirely of constant forces of attraction between material particles. They dealt, therefore, only with conservative systems of forces.

Now, as von Helmholtz points out in a preface which he has written to this work of his favourite and greatest pupil, physicists gradually learned to handle problems in which conservative forces were combined with fixed connections. General methods of solution were developed, such as d'Alembert's principle, the principle of least action as variously expressed by Maupertuis, Jacobi, and Hamilton, Gauss's principle of least constraint, the principle of the conservation of energy, and others. All these propositions were discovered and proved under the limitations involved in Newton's assumptions, but observation gradually showed that they could claim a much more general validity in nature than could be inferred from the manner of their demonstration.

It was therefore concluded that certain general characteristics of Newton's conservative system of forces, based upon the theory of action at a distance, were common to all natural forces, but hitherto no proof has been offered that such a generalisation could be logically deduced from a simple and common basis.

This has been the problem which Hertz has set himself in the present work, and of which he has given a solution. As he says in his preface, "whether the presentation here given as the solution of this problem is the only possible one, or whether there are other and perhaps better possible ones, remains open."

That it is a possible solution, he has proved by developing its consequences, and showing that these consequences, while including nothing inconsistent with our present state of knowledge, embrace the whole content of ordinary mechanics. This is an extremely important step in advance, for it frequently occurs in the consideration of new problems, at present perhaps mainly, though by no means exclusively, in connection with electro-magnetic theory, that the question arises as to whether certain assumptions are or are not in accordance with the accepted laws of mechanics. The author points out that the existence of such open questions forms at times a real bar to progress, and, as an example, observes that it is premature to attempt to deduce equations of motion for the ether until a definite agreement has been arrived at with respect to the mechanical assumptions on which they are to be based.

The introduction occupies 41 pages, and very fascinating pages they are; they can, moreover, be read with advantage by every physicist interested in the foundations of our knowledge of dynamics, even if his mathematical attainments are not of the somewhat high order necessary to enable him to follow the complete development of the author's system in the subsequent chapters.

The philosophical point of view is that of Kant, but while the reader familiar with the writings of that philosopher will more immediately feel at home in the author's point of view, a knowledge of the Kantian system is not by any means essential to the due appreciation of his line of argument.

He opens this argument by calling attention to the fact that when we endeavour to make use of our past experience of nature to predict future occurrences, we form for ourselves images of external objects, which, in order to make such prediction possible, must be of such a character that "the necessary consequents of the images in thought are always the images of the necessary consequents in nature of the things pictured. These images are our conceptions of the external world, and our experience shows that there is so much conformity between nature and our own thought

as to fulfil this requirement. Whether there is any further conformity between our conceptions of things and the things in themselves we cannot possibly have any means of knowing. Now these images are not uniquely determined by the above requirement, for various images of the same objects are possible, but of these we must exclude as not logically permissible any which contradict the laws of thought, and then from these permissible ones select those which fulfil the above fundamental requirement, that their essential relations shall not contradict the essential relations of external things. Of those that are left we should select as the more appropriate, firstly, those images which we may designate as most distinct, that is to say, which picture most of the essential relations of the object; and secondly, those which are most simple, that is to say, those which contain, in addition to the essential charactertistics, the smallest number of superfluous or empty relations. With regard to the scientific representation of the images, further postulates are required, in order that we may be in the best position to modify and improve them; namely, the representation should be such as to lead us to a clear conception of the properties to be ascribed to the images for permissibility, for correctness, and for appropriateness respectively.

The first class are determined by the nature of our thought, so that the results are determinable without ambiguity and independently of either time or experience. The second class are also determinable without ambiguity, but only according to the present state of our experience, and may require modification in the light of later experience. The third class, which include notations, definitions, and, in fact, whatever can be arbitrarily added or taken away, are not determinable without ambiguity, but leave room for difference of opinion, and it is only by gradually testing many images, in these respects, that the most appropriate can be obtained.

From these standpoints the author proceeds to consider the representations which have been given of the principles of mechanics.

What was originally meant by a principle of mechanics was such a statement as could not be traced back to other mechanical propositions, but was regarded as a direct result obtained from other sources of knowledge, but, as the author observes, it inevitably happened in the course of historical development, that propositions which, at the time, and, under the then existing state of knowledge, were rightly called principles, can under present conditions of knowledge only be considered as general propositions. The result has been that the idea of a mechanical principle has not been kept sharply defined, and while the author retains the accustomed names for these propositions, he defines a Principle of Mechanics to consist of any selection from amongst such or similar propositions which satisfies the requirement that the whole of mechanics can be developed from it by purely deductive reasoning without any further appeal to experience.

The fundamental ideas of mechanics therefore, together with the principles connecting them, represent the simplest available image of things in the sensible world and the processes occurring in it. By choosing difficult propositions as fundamental, various images can be obtained, and can be tested and compared with each other in respect of their permissibility, correctness, and appropriateness.

The first image considered by the author is the customary representation of mechanics based upon the ideas of space, time, mass, and force, force being introduced as the cause of motion and existing before motion and independently of it. In this method space, time, and mass are connected by Galileo's conception of inertia, and the few fundamental ideas are first linked together by Newton's "Laws of Motion." These alone do not furnish a general expression for the influence of rigid spacial connections, which was first stated explicitly in the form of d'Alembert's principle, which extends the general results of statics to the case of motion. Although not stated explicitly by Newton, d'Alembert's principle is distinctly implied in his own *scholium* to his third law, as Thomson and Tait have pointed out (Nat. Phil. § 263). Newton's laws and d'Alembert's principle together form a complete group of principles or fundamental statements from which everything else can be derived by deductive inference.

The difficulty in the accustomed presentation lies entirely in what is to be understood by force, and it is one which is universally felt and acknowledged by physicists. The author suggests that the logical obscurity as to the exact meaning to be ascribed to the word force may arise from the conception of force, assumed and created in us by Newton's third law, being slightly different from that of his first two laws.

As to the correctness of the image under consideration there is no doubt. This correctness, however, has only been secured by making the reservation that, if need be, facts derived from subsequent experience should modify the meanings of the definitions, and the author very justifiably observes that in a perfect science such groping, giving only an appearance of certainty, is inadmissible.

With regard to the third point, the appropriateness of the image, it certainly is not one that can be considered perfectly distinct, as it does not contain all the characteristics which our present knowledge enables us to distinguish in natural motion. In other words, many of the motions which the fundamental laws admit do not occur in nature.

Instances of this in quantity may be found in mechanical text-books and Cambridge problem papers of twenty years ago and upwards, which are full of mathematical problems dealing with motions which are in accordance with the fundamental laws, but which have no counterpart in nature. Many of these, for example, violate the principle of the conservation of energy, the truth of which is universally acknowledged.

Within recent years most of these non-natura problems have been eliminated both from text-books and examination papers, mainly through the

influence of Lord Kelvin and Professor Clerk Maxwell and their successors, but a system of mechanics which includes so much more than exists in nature cannot be considered a theoretically satisfactory one.

A second image of mechanical processes which would at first sight appear more likely to meet the requirements of modern physics, in which energy plays so prominent a part, might be obtained by taking space, time, mass, and energy as four independent fundamental ideas to start with, and connecting them together by means of one of the integral principles of ordinary mechanics, as, for example, "Hamilton's Principle."

The sole fundamental law of mechanics would then be that:—Every system of natural bodies moves just as if it were assigned the problem of attaining given positions in given times, and in such a manner that the average over the whole time of the difference between kinetic and potential energy shall be as small as possible.

Force would then come in naturally as a derivative idea convenient for the consideration of cases of transference of energy between different masses.

Introduced in this manner, the idea of force could not involve any logical difficulties, as the properties of forces would be derived entirely from the definition and the fundamental law, without the aid of experience.

This image would certainly have a great advantage over the ordinary one in appropriateness, owing to its greater simplicity, for as the author pertinently observes:—The real reason for the preference shown for expressing physical problems in terms of energy is because in this way it is easiest to avoid talking about things of which very little is known, and which do not affect the essential elements under consideration. It enables us in general to avoid the introduction of actions between atoms and molecules of which very little is known, and which even if they were known would introduce so many variables into the mathematical treatment of almost any physical problem as to make it entirely unmanageable. With the image under consideration this difficulty is avoided altogether, with the ordinary one it is merely turned, by means of more or less arbitrary assumptions.

Unfortunately however considerable difficulties arise when we begin to consider the correctness and the logical permissibility of the image.

Hamilton's principle can be deduced from the accepted foundations of Newtonian mechanics, but only by means of certain assumptions, and these limit it so that it does not apply to all natural motions, for it requires that if fixed connections exist between the chosen co-ordinates of a system, these connections must be expressible mathematically by finite equations between the co-ordinates, which is not always the case in natural motions. For example, when bodies of three dimensions roll upon each other without slipping there must necessarily be at least one non-integrable differential equation connecting the co-ordinates. The application of Hamilton's principle would therefore in this case lead to physically false results unless it be admitted—and for this there appears to be no reason—that rolling without some slip is a motion essentially impossible in nature.

Even if this difficulty were overcome the author finds still more formidable ones in trying to arrange the elements of the system in accordance with the requirements of logical permissibility. In developing this image it is necessary, without assuming any previous consideration of mechanics, to specify some simple, direct experiences, by which the presence of a store of energy may be defined, and its amount determined. Kinetic energy does not require a new fundamental determination, as it can be deduced from the ideas of velocity and mass, but this does not apply to Potential energy, and as the author has not been able to see his way to such a definition for it, he has put this presentation aside, regarding it for the present as an open question whether it may be possible to develop it in logically unexceptionable form. He therefore proceeds to the consideration of a third image, the development of which forms the subject of the present work.

He first introduces, as objects of experience, the three independent fundamental ideas of time, space, and mass, and then specifies the concrete sensible experiences by which these are to be determined. With regard to the masses, he assumes that, in addition to the masses recognisable by the senses, concealed masses may be introduced, and expresses the existence of forces between bodies not directly in contact with each other in terms of the motions of these concealed masses.

As noteworthy examples of the use of this hypothesis of concealed masses, in order—to use the language of ordinary Newtonian mechanics—to explain the existence of forces between bodies not in contact, we may mention Lord Kelvin's theory of vortex-atoms, and the hypothesis of ether-whirls adopted by Maxwell, and so ably developed by Fitzgerald and Oliver Lodge, for the explanation of electro-magnetic phenomena.

The general connection between the three fundamental ideas of time, space, and mass is given by the author in the form of a single fundamental law which exhibits a close analogy with the usual law of inertia; in fact, it condenses into a single statement the Law of Inertia and Gauss's "Principle of Least Constraint." To make the statements of this law intelligible will necessitate a few preliminary considerations. The author approaches the subject from the most general point of view, and introduces at once the idea of a material system, or, as we shall put it shortly, a system, consisting of any number of masses disposed in any manner.

The position of a system is defined as the aggregate of the positions which all the points of the system occupy simultaneously. The path of a system is defined as the aggregate of positions which the system occupies in its passage from one position to another.

The masses of a system may or may not have connections existing between them. Of these connections those are said to be internal which only affect the relative positions of the points of the system, and those are said to be normal which exist independently of the time.

A system which is subject to no other than internal normal connections is called a free system. It will be seen that in a system in which connections exist, only some paths will be possible to the system, so that we must distinguish between possible and impossible paths.

An element of a path of a system is said to be straighter than any other when it has a smaller curvature, and the straightest element is defined as a possible element, which is straighter than all other possible ones which have the same position and direction. A path, all of whose elements are straightest elements, is called a straightest path.

We shall now be in a position to understand Hertz's fundamental law of mechanics, namely, *Every free system persists in its state of rest or of uniform motion in a straightest path.*

This, like Newton's laws of motion, is simply a statement of experience, and, like them, it has to be judged by its accordance with observed facts. The present work is devoted to the development of the consequences of this law, which are worked out with great mathematical ability and acuteness of reasoning, and shown to include all the laws of mechanics which have been recognised as of general validity.

The volume is divided into two books, in addition to the introduction. The first of these treats of the Geometry and Kinematics of Material Systems, and the second, in which the idea of mass is first introduced, deals with the Mechanics of Material Systems.

The mathematical methods employed are those which are naturally suitable to the extremely general manner in which, as we have already indicated. the problems of mechanics are approached. The whole system of treatment is of a character pre-eminently suitable for the investigations of electro-magnetism, including of course its branches, the theories of heat and light; the physics of the ether, the dynamics of chemical phenomena, and many other recondite problems awaiting solution, but it need hardly be said the author does not propose that his system should displace the ordinary one for the teaching of mechanics. Very restricted indeed would be the number of students of mechanics if the only road to even an elementary knowledge of the subject lay through the domain of generalised Lagrangian co-ordinates, to be traversed only by the aid of partial differential equations and the calculus of variations.

This is not the place for a detailed consideration of the mathematical treatment of the subject, but we cannot refrain from calling the attention of our mathematical readers to the natural and elegant manner in which Hamilton's principle and the allied integral principles are evolved, and the existence of Hamilton's characteristic and principal functions demonstrated from the author's fundamental law, and confined to their proper sphere, that of what the author calls ***holonomous*** systems; in other words, systems whose differential equations are all integrable in finite terms, and which may therefore be said to obey integral laws. It may be shown that the necessary and sufficient condition for a system to be ***holonomous*** is that all conceivable continuous motions between its possible positions should also be possible motions.

A careful study of the work has convinced us that the author is justified in the statement with which he concludes it, viz.: "We may assert that the fundamental law is not only necessary, but also sufficient to represent completely the part which experience plays in the general laws of mechanics."

Our feeling as we rise from the perusal of this powerful and original treatise is one of poignant regret that its highly gifted author should have been cut off by the hand of death in the very zenith of his power, and before he had taken, as far as we know, even a first step towards the application of the principle of concealed motions, with the aid of the powerful instrument which he has forged, to the explanation of physical phenomena.

Health in the Workshop. A Paper read before the Manchester Association of Engineers on Saturday, February 24th, 1900, by Mr. J. D. Sutcliffe, Manchester.

We think that the Sutcliffe Ventilating and Drying Co. have acted wisely in publishing separately the paper above described, as it contains many valuable hints on workshop sanitation, which in the transactions of a learned society are not sufficiently accessible to those for whom they have the greatest value. The author very strongly emphasises the fact that the money spent in the sanitation of the workshop, and in rendering it clean and comfortable, is the most profitable investment any employer of labour can make, and ascribes a good deal of the success of foreign competition to the more perfect management of workshops abroad, as compared with our own. Thus in America it is no uncommon occurrence to spend 20 to 25 per cent. of the total cost of a building for adequate warmth and fresh air, while it is equally common, unfortunately, for an English architect to allow in his estimates £5 for a so-called "ventilating cowl," to be fixed by the builder on the roof, and this has been known, according to Mr. Sutcliffe, where the building cost over £5,000. After describing the practice of testing the air in workshops by ascertaining the percentage of carbonic acid gas, which, if it exceeds nine parts in a hundred, indicates the presence of other noxious gases and vapours to a harmful extent, the author describes very lucidly, in connection with illustrations, the motion of the inflowing and outflowing air when the inlet and outlet occupy certain relative positions in a room, dispelling at the same time a good many preconceived ideas. This is followed by a full account of the most effective arrangement for ventilation, and great stress is laid upon the importance of ventilating closets and other places of convenience in such a manner as to drive the tainted air outside, instead of drawing it by faulty arrangements inside of the building, as is done only too often. Of equal interest and importance are the author's remarks on the means of removing dust in shops where emery-wheels and grind-stones are manufactured, and in potteries; and his hints for purifying and ventilating weaving sheds.

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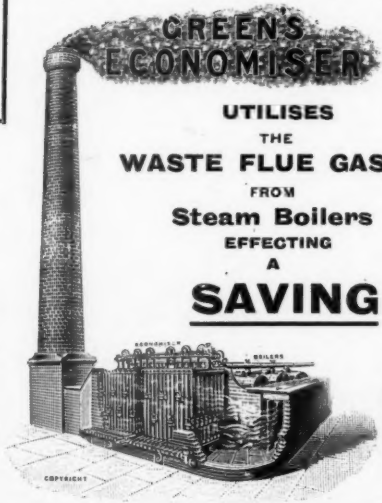

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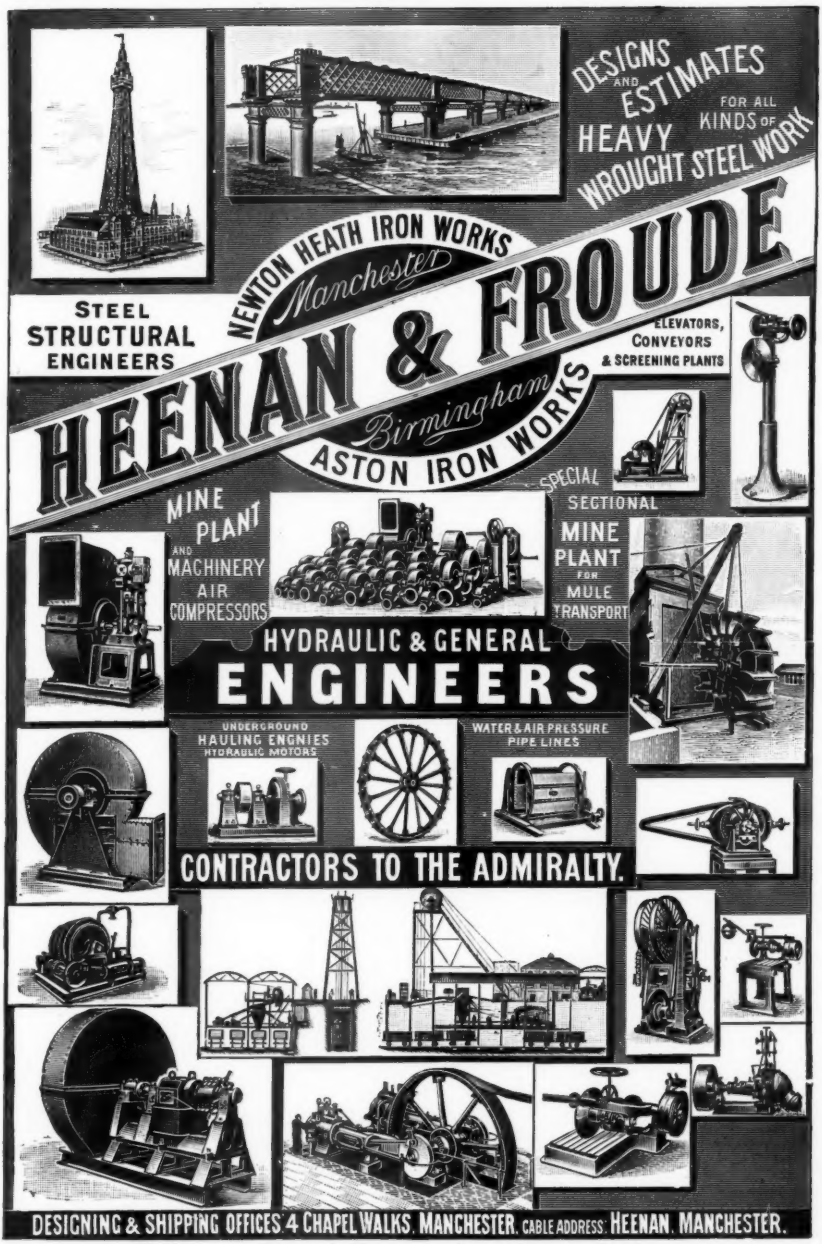
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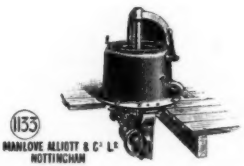

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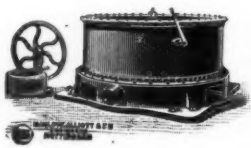

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This list contains (on pages xiii and xvi) the names, postal, telegraphic and cable addresses, and codes used, together with (on this page in English, and on pages v and vii in French and German respectively) the specialities manufactured by

Leading British Firms in the Engineering, Shipbuilding and Allied Industries.

☞ *To ascertain the Names of Firms Manufacturing any of the Specialities in the following List, take the numbers indicated against each name and refer to the corresponding numbers in the List of Firms on pages* xiii *and* xvi.

For the benefit of the readers of this Magazine, the proprietors have organised a special department of their business, in which the Catalogues and Price Lists of the firms named in this Directory are preserved for reference. They can be consulted free of any expense at all times by subscribers to or advertisers in FEILDEN'S MAGAZINE, and any inquiries will be freely answered either by letter or personally.

This organisation possesses special facilities for securing *inside* information not otherwise obtainable. Correspondence from any part of the world will receive immediate attention, and the wants and requirements of Foreign and Colonial buyers will be catered for in a manner hitherto but imperfectly done by other agencies. The most authentic information will be vouchsafed to readers as to the merits of the respective specialities advertised.

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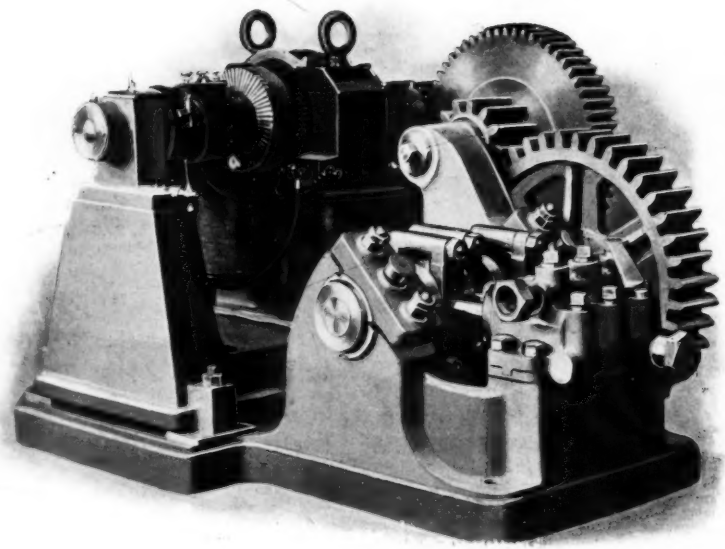

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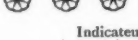
Cette liste contient, sur les pages xiii et xvi, les noms et les adresses postales et télégraphiques des

Principales Maisons de Nations parlant la langue anglaise s'occupant de travaux du Génie, de la Construction de Machines et de Navires et se livrant à d'autres Industries analogues.

Avec indication sur cette page, du genre d'industrie dont chacune de ces Maisons fait sa spécialité.

☞ *Pour savoir les noms de maisons qui fabriquent quelqu'une des spécialités comprises dans la liste suivante, prendre les numéros vis-à-vis de chaque nom et chercher les numéros correspondants dans la liste des maisons, sur pages* xiii *et* xvi.

Dans l'intérêt des lecteurs de ce Journal, ses éditeurs ont organisé dans leurs bureaux un service spécial pour la conservation des catalogues et prix courants des diverses Maisons figurant dans la liste, afin de pouvoir s'y reporter au besoin. Ces imprimés peuvent à tout moment être consultés, sans frais, par les abonnés du FEILDEN'S MAGAZINE et les personnes qui font paraître des annonces dans cette publication. On répond, en outre, soit par lettre affranchie, soit personnellement, à toute demande de renseignements.



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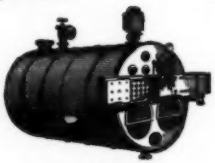
In the Century which is opening, the race for industrial supremacy will be to the swiftest. The time is gone by for time-honoured old houses to consider they are strong enough to do without advertising. So sure as America and Germany will occupy increasingly strong positions among the nations of the world will British manufacturers be compelled to give closer and closer attention to their advertising literature. Not a point must be lost. The man who has a good thing to advertise and fails to keep this fact consistently and persistently before the world—his world of probable buyers—will be run out of the race. If the old-established firms hide their lights under a bushel, the younger and more progressive will forge to the front. FEILDEN'S MAGAZINE has proved itself essentially the biggest business "boomer" in Engineering literature. In 1901 it hopes to break its own record. Enterprising firms who wish to expand their connections are advised to book their space before the advertising rates are again advanced.

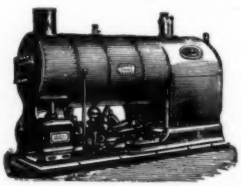
DAVEY, PAXMAN & Co., Ltd.,

COLCHESTER, England. Engines in all Sizes up to 1,500 h.p.

"ESSEX" PATENT VERTICAL BOILER.
FROM 2 H.P. AND UPWARDS.



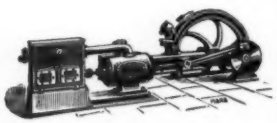
"ECONOMIC" STEAM BOILER.
FROM 6 H.P. AND UPWARDS.



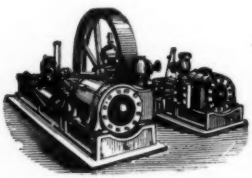
SEMI-FIXED COMPOUND ENGINE.
FROM 8 H.P. AND UPWARDS.

MAKERS OF

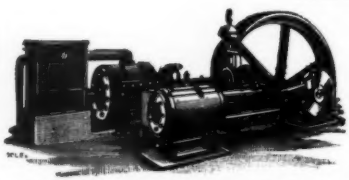
- High Speed Engines
- Semi-Fixed Engines & Boilers
- Horizontal Engines
- Vertical Engines and Boilers
- Horizontal Winding Engines
- Vertical Hoisting Engines and Boilers
- Compound Portable & Semi-Portable Engines
- Compound Horizontal Fixed Engines
- "Windsor" High Speed Non-Compound Vertical Engines
- Corliss' & Trip-Gear Engines
- Air Compressors.



IMPROVED HORIZONTAL GIRDER ENGINE.
FROM 4 H.P. AND UPWARDS.

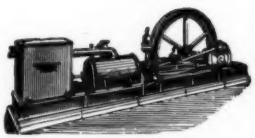


COUPLED HORIZONTAL ENGINE.
FROM 40 H.P. AND UPWARDS.

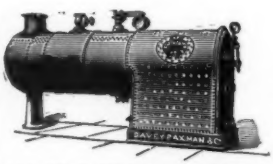


COUPLED COMPOUND GIRDER ENGINE.
FROM 12 H.P. AND UPWARDS.

Highest Awards at . . Exhibitions.



HORIZONTAL ENGINE.
FROM 12 H.P. AND UPWARDS.



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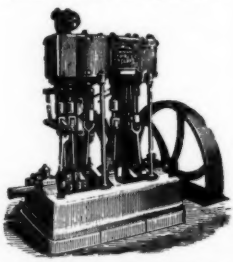
FROM 4 H.P. AND UPWARDS.

Catalogues, Price Lists, Photos, and Estimates Post Free on application.



"WINDSOR" HIGH-SPEED VERTICAL COMPOUND ENGINE.
FROM 4 H.P. AND UPWARDS.

Feilden's Magazine: Des Käufers Rathgeber.

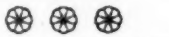
Vorliegende Liste an zeite xiii und xvi enthält die Namen so wie die Adressen für Correspondenz und Telegramme

der hervorragendsten Englisch-sprechenden im Ingenieurwesen, dem Maschinen- und Schiffbau und den damit verwandten Industriesweigen thätigen Handels- und Fabriksanstalten.

Nebst Angabe der von denselben erzeugten resp. in den Handel gebrachten Specialitäten.

☞ *Um die Namen der Firmen, welche irgend eine der in der folgenden Liste enthaltenen Specialitäten fabriciren, zu finden, bemerkeman die jedem Namen beigefügte Nummer und suche die entsprechende Nummer in der Firma-liste, Seite* xiii. *und* xvi.

Im Interesse unserer Leser haben wir in unserem Verlagslocal eine besondere Abtheilung zur Aufbewahrung und evtl. Einsicht von Catalogen und Preislisten der im Adressbuch angegebenen Firmen reservirt. Die Benützung derselben steht den Abonnenten und Inseranten jederzeit absolut unentgeltlich frei. Auch werden sämmtliche an FEILDEN'S MAGAZINE gerichtete Anfragen gern entweder brieflich oder mündlich beantwortet.



Asbestwaaren Fabrikanten ... C17, S7
Aufzug und Afterläuber G2, H12
Bergbaumaschinen B2, D14, H12, L7, R17
Biegemaschinen B5
Blasebälge und Ventilatoren ... M27, S22
Bogenlampe D10
Brauerei-Ingenieure B20
Brücken G7, H12
Büchsen für Aschenlagez ... P9
Centrifugal-Trockenmaschine ... B13, M3, W17
Condensatoren und Condensir-Anlagen E11
Conveyers (Aufzuge) H12, W18
Corliss-Getriebe T5
Dampfbagger R17
Dampfbarkassen R14
Dampfmaschinen und Locomotiven B17, B22, B24, C19, D3, E11, G1, H24, M5, O4, R17, W3
Dampfventile L3
Desinficirapparat M3, M12
Draht-Fabrikanten S11
Dynamomaschinen B1, B17, B26, M27, N3, R19
Eisen und Stahl Röhren ... L12
Eisen und Stahlfabrik Anlagen B5
Eisenbahn-Betriebsmaterial ... B17, F9, G7, P9
Eisenbahn-Wagen B17
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Elektrischer Draht und Kabel ... G15
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Galvano plastiche Anlagen ... B8
Gas Ingenieure B7, C13, C14, G2, K3, W18, W20
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Kolben L3
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Luftpumpen H7
Luftschiffsschrauben M27
Luftverdichter T4
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Maschinen und Kesselausrüstung E11
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Messinggiesserei E11, L3, S25
Metalle A11, D11, P7
Metall- Dichtung L3, M33, S7, U1, V3
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Rohrdichtung B1
Röhren L12, P10, R17
Rotirende Achsenlager A15, F7
Schiffsbauer R14
Schleitmaschinen G10, L15
Schmiedstücke M31
Schmiedepressen R18
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Vorwärmer des Speisewassers ... M12, M27
Wasserbehälter B29
Zeichen- und Erdmessungsinstrumente A7, M28
Zuckermaschinen M3

AN . . .

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See pages lxxix and lxxx.

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"Syphonia, London."

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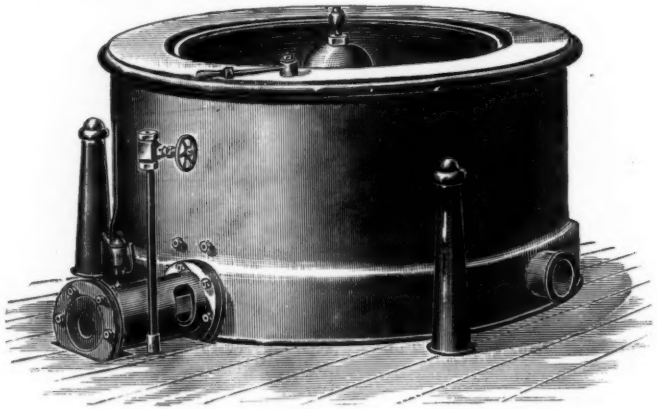

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Average For the Year 1900 NEARLY 10,000!!! Copies per Month.

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CHARTERED ACCOUNTANTS.

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35-56, *Bishopsgate Street,*
London, E.C.
1st November, 1900.

Dear Sirs,

In accordance with your instructions, we have examined the Circulation Books of the Feilden Publishing Co., Ltd., and we certify that the average number of copies printed of "Feilden's Magazine," from January to September, 1900, amounted to 9,572 copies per issue, and that the average circulation (after deducting returns) amounted to 7,869 copies per issue.

The first printing order for the November issue is 10,036 copies.

Yours faithfully,
(Sgd.) E. LAYTON BENNETT & Co.

The Directors,
Messrs. The Feilden Publishing Co., Ltd.,
Temple Chambers, Embankment, E.C.

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Advertising spaces for 1901 now being planned. Early application is necessary to ensure remaining good positions.

Address: THE MANAGER, ADVT. DEPT.,
THE FEILDEN PUBLISHING CO., LTD.,
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FEILDEN'S MAGAZINE.

Some Forthcoming Articles in the FEBRUARY and MARCH (1901) Issues.

Thermal Efficiency of Steam Engines.
W. D. WANSBOROUGH.

Steam Turbines for Electric Lighting.
JOHN BARKER, M.I.E.E.

British Commercial Supremacy.
ERNEST D. PHILLIPS.

Gold Mining Machinery.
PHILIP R. BJÖRLING.

Midland Railway Enterprise: New Line from New Mills to Heaton Mersey.
C. E. ALLEN, A.I.Mech.E.

Electrical and Lift Equipment of the Central London Railway.
W. N. TWELVETREES, M.I.Mech.E.

Power Hammers.
ERNEST SAMUELSON, M.Inst.C.E., M.I.Mech.E.

The Development of the White Lead Industry.
L. M. G. CUTHBERTSON, F.C.S.

Steam Pipes at Sea and on Shore.
STEPHEN H. TERRY, M.Inst.C.E.

Succeeding Numbers of FEILDEN'S MAGAZINE will contain some Articles by great writers of the utmost commercial and technical value. Arrangements have already been made for the publication of upwards of Fifty Special signed Articles on vitally important subjects. With the exception of above list, which applies to the next two issues, we have no space to enumerate them here.

12/6 sent NOW will place you on our subscription list for a year's issues (including special numbers), post free, on the finest English art paper. *We cannot guarantee any back numbers of the issues for 1901.* Therefore, ensure getting your copies by subscribing NOW.

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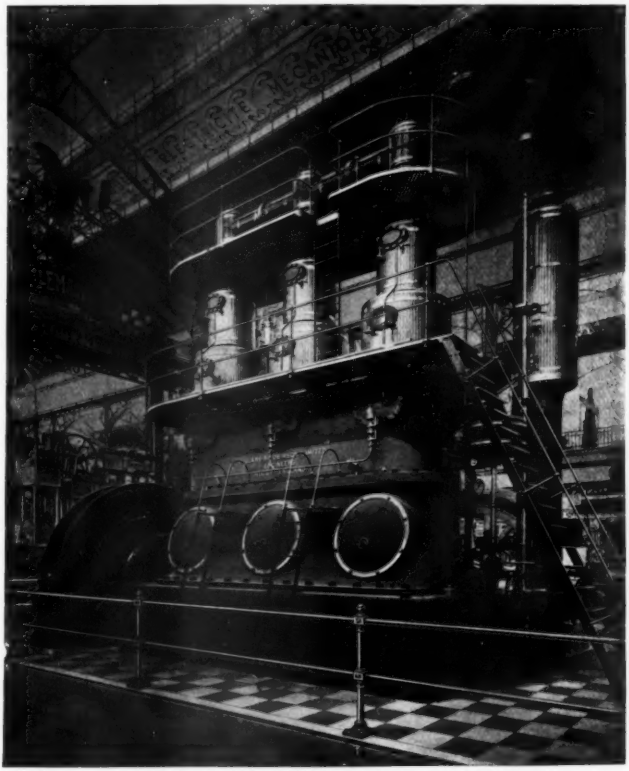
Willans'

CENTRAL VALVE

Engine.

Grand Prix, Paris, 1900.



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The "LANCASTER"
(R.T.M.)

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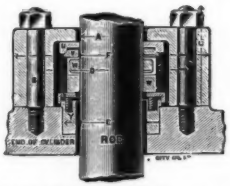
Steam Traps



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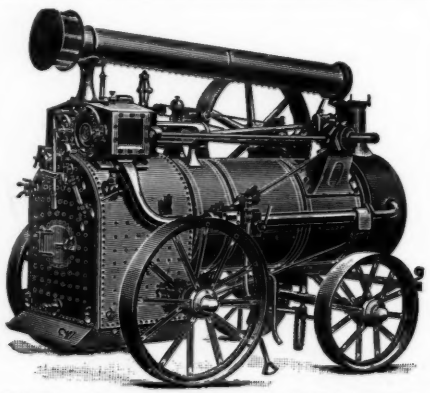
DEVIZES, Eng.



This illustration represents a 12 (Nominal) H.P. COMPOUND Portable Engine, fitted with high-speed sensitive Governor capable of developing 30 brake H.P. in normal work. Coal consumption (with maximum load) 2·77 lbs. of coal per brake H.P. per hour.

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FEILDEN'S MAGAZINE: Directory.
The numbers against the names refer to the corresponding numbers against the Specialities on pages iii, v, vii.

FEILDEN'S MAGAZINE: Annuaire de l'Acheteur.
Les numéros en regard des noms se rapportent aux numéros correspondants en regard des Spécialités aux pages iii, v, vii.

FEILDEN'S MAGAZINE: Des Käufers Rathgeber.
Die Nummern neben den Namen beziehen sich auf die betreffenden Nummern neben den Specialitäten auf Seiten iii, v, vii.

List of Codes:

1. A1.
2. A B C.
3. Engineering.
4. Moreing's.
5. Moreing and McCutcheon's.
6. Lieber's.
7. Hawke's Premier.
8. Unicode.
9. Bedford McNeill's.
10. Ager's.
11. Standt and Hundin's.
12. Moreing and Neal's.

		Name of Firm. / Nom de la Maison. / Name der Firm.	Postal Address. / Adresse Postale. / Postadresse.	Telegraphic or Cable Address. / Adresse Télégraphique. / Telegraphische oder Kabeladresse.	Telephone No. / Telephone No. / Fernsprecher No.	Codes used. / Codes / Coden.
A	1	ACME TONE ENGRAVING CO., Ltd. ..	Watford, Herts.; 9, Arundel St., Strand, W.C.	Acme, Watford ..	25, Watford 4008 Gerrard	....
A	2	ADDY, GEORGE	Sheffield	Milling, Sheffield ..	Nat. 985	....
A	8	ASKHAM BROS. & WILSON, Ltd.	Sheffield	Askham, Sheffield ..	.....	....
A	9	ATLAS ENGINEERING CO.	Atlas Tool Works, Levenshulme, Manchester	Atlas Works, Levenshulme	6095	....
A	15	AUTO-MACHINERY CO., Ltd.	Read Street, Coventry	Auto, Coventry	.....	....
B	1	BAGSHAWE & CO.	¾ Tower Royal, Cannon Street, London, E.C.	Outburst, London ..	.....	1, 2
B	2	BOWES-SCOTT & WESTERN, Ltd.	Broadway Chmbrs., Westminster	Donbowes, London ..	199 Westminster	....
B	5	BERRY, HENRY & CO., Ltd.	Croydon Works, Hunslet, Leeds	Rivetter, Leeds ..	587	3, 2
B	13	BROADBENT, THOS. & SONS, Ltd. ..	Chapel Hill, Huddersfield ..	Broadbent, Huddersfld., Syphonia, London	102	1, 2, 6
B	14	BRITISH TELAUTOGRAPH CO., Ltd. ..	19, New Union Street, Moorgate Station, London, E.C.	.....	.....	....
B	17	BRUSH ELECTRICAL ENGINEERING CO., Ltd.	49, Queen Victoria Street, E.C...	Magneto, London ..	910 Bank	1, 2
B	18	BRITISH SCHUCKERT ELECTRIC CO., Ltd.	Surrey St., Strand, London, W.C.	.....	1689 Gerrard ..	2, 11
B	19	BROWN & CO.	49, Deansgate, Manchester ..	Brownish, Manchester .	4337	2
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B	23	BROWN & MAY, Ltd.	North Wilts Foundry, Devizes ..	Foundry, Devizes ..	6	2
B	23	BILLS, HANDLEY & CO.	50, Summer Row, Birmingham ..	.....	.....	....
B	24	BROWETT, LINDLEY & CO. (1899) Ltd.	Sandon Engine Works	Sandon, Fatricroft ..	10, Eccles ..	....
B	26	BRITISH WESTINGHOUSE ELECTRIC AND MFG. CO., Ltd.	Norfolk Street, Strand W.C. ..	Multiphase, London ..	4045 and 4047 Gerrard	....
B	27	BEDFORD ENGINEERING CO.	Bedford	Cranes, Bedford ..	Nat. 33	....
B	28	BRITISH POWER TRACTION & LIGHTING CO., Ltd.	Hull Road Works, York	Metals, York ..	Nat. 0226	2
B	29	W. P. BUTTERFIELD	Shipley, Yorks	Tanks, Shipley	Nat. 35 Shipley ..	....
C	3	CAMPBELL GAS ENGINE CO., Ltd. ..	Halifax	Camgas, Halifax ..	92	3, 2
C	4	CASE SEA DEFENCE SYNDICATE, Ltd..	Canal House, Maidstone	.....	.....	....
C	5	CARRUTHERS, J. H. & CO.	Polmadie Iron Works, Glasgow ..	Hoisting, Glasgow ..	.....	2
C	6	CHAMPION FRICTION CLUTCH CO., Ltd.	Trent Street, Attercliffe, Sheffield	.....	.....	....
C	13	CUTLER & SONS	Providence Ironworks, Millwall ..	Retortus, London ..	59, Eastern ..	....
C	14	CLAPHAM BROS., Ltd.	Keighley	.....	.....	....
C	15	CROMPTON & CO., Ltd.	4, Queen Victoria St., E.C.	Crompton, London ..	663 Bank	1, 2, 3, 10
C	17	CAPE ASBESTOS CO., Ltd.	8, Minories, London, E.C. ..	Incorruph, London ..	272	1, 2
C	18	COULTHARD & CO., Ltd.	Cooper Road, Preston, Lancs. ..	Coulthard's, Preston ..	140, Preston	....
C	21	CLARKE'S CRANK & FORGE CO., Ltd. ..	Lincoln	Cranks, Lincoln ..	.....	2
C	22	COBBETT W. WILLSON, Ltd.	59, Southwark St., London, E.C.	Scandinavia, London ..	25, Hop	2
C	23	CONSOLIDATED TELEPHONE CONSTRUCTION & MANUFACTURING CO., Ltd.	38, Victoria Street, S.W.	.....	.....	....
C	24	R. CUNDALL & SONS, Ltd.	Shipley, Yorks	Cundall, Shipley ..	Nat. 75 Shipley ..	...
D	3	DAVEY, PAXMAN & CO., Ltd.	Standard Ironworks, Colchester..	Paxman, Colchester ..	.....	1,
D	9	DAVIES, GEO. & CO.	Abergavenny, Mon.	Engineer, Abergavenny	P.O. 4	....
D	10	DAVY, W. J.	3 & 5, Crown Court, Old Broad Street, E.C.	Management	152, Avenue	....
D	11	DELTA METAL CO., Ltd.	110, Cannon Street, E.C.	Delta, London	Avenue, 11,292 ..	2
D	12	DRUM ENGINEERING CO.	27, Charles Street, Bradford ..	.....	.....	....
D	14	DAVIS, JOHN & SON	All Saints Works, Derby	Davis, Derby	240	1, 2
D	15	DAVIS & PRIMROSE, Ltd.	Gt. Junction St., Edinburgh ..	Etna, Leith	.....	1, 2
D	16	DRYSDALE & CO...	Bon Accord Engine Works, London Road, Glasgow	Bon Accord, Glasgow..	2505..	....
D	17	DEMPSTER, MOORE & CO.	49, Robertson Street, Glasgow ..	Dempster, Glasgow ..	505	2
E	6	EVANS, JOSEPH & SONS	Culwell Works, Wolverhampton	Evans, Wolverhampton	39	2
E	7	EDWARDS AIR PUMP SYNDICATE, Ltd.	3 & 5, Crown Court, Old Broad Street, E.C.	Management, London,	152 Avenue ..	2, 3, 9
E	9	EDISON & SWAN UNITED ELECTRIC LIGHT CO., Ltd.	36 & 37, Queen Street, Cheapside, E.C.	Ediswan, London ..	805 Bank	....
E	10	EMMOTT & CO.	Victoria Works, Stalybridge ..	Emmott, Stalybridge ..	156	....
E	11	ERNEST SCOTT & MOUNTAIN, Ltd. ..	Close Works, Newcastle-on-Tyne	Esco, N'castle-on-Tyne	1250, P.O., 432..	1, 2
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(Continued on page xvi.*)*

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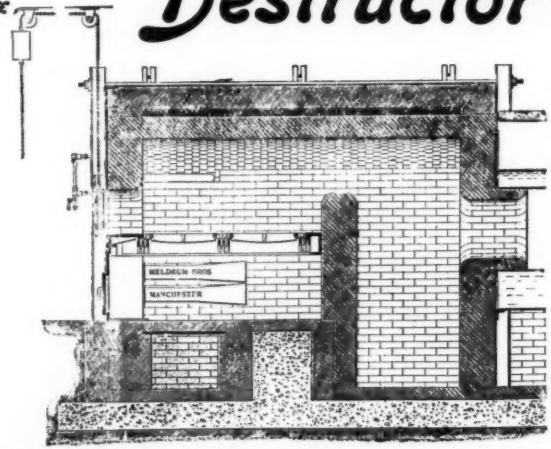

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A Saving in Fuel of £18 per week.

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	Kind of Fuel.	Cost of fuel per Ton.	Water Evaporated per Pound of Fuel.	Cost of fuel per 1,000 Gallons Evaporated
		s. d.	lb.	*s. d.*
A.	Dust coke.....	5 0	6	3 8
B.	„ Welsh coal...	10 0	8	5 3
C.	Large „	22 0	9	10 11

Discovering that the Sheffield Gas Company made a considerable quantity of coke dust, which they gave away to builders and others, we entered into a contract for a supply for three years. Having a spare boiler, we had Meldrums' forced draught fitted, and soon discovered that coke dust made a very satisfactory fuel for steam raising. Our second boiler was then fitted, and we are now burning coke dust on the two almost exclusively. From an economical point of view the experiment is very satisfactory, as will be seen from the following figures:—

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45 tons at 12*s.* 6*d.*	28	2	6
Ashes at 2*s.*, 7 loads.....	0	14	0
	£28	16	6

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Coke dust	3	4	0
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Ashes, 12 loads at 2*s.*	1	4	0
	£10	5	6

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FEILDEN'S MAGAZINE: Des Käufers Rathgeber.
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4. Moreing's.
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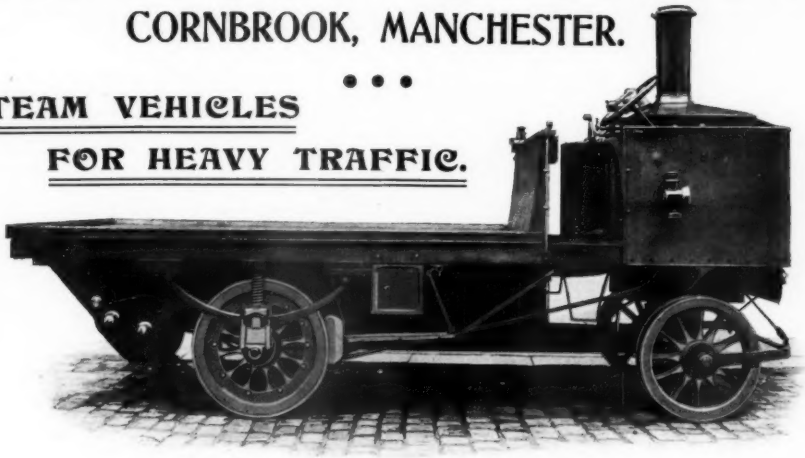

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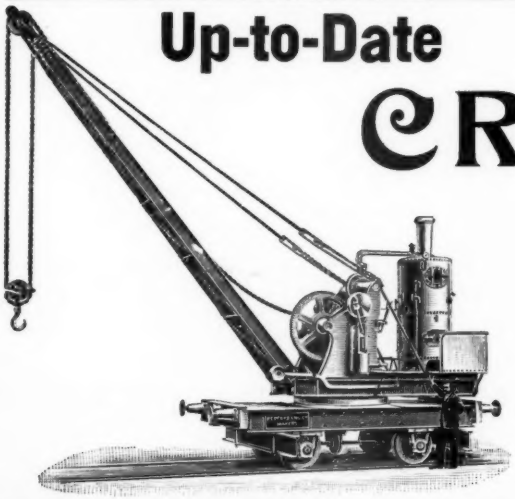

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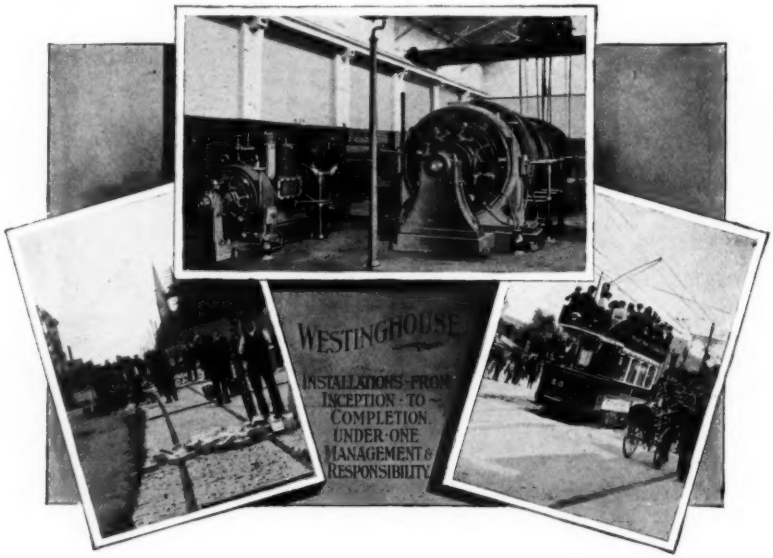

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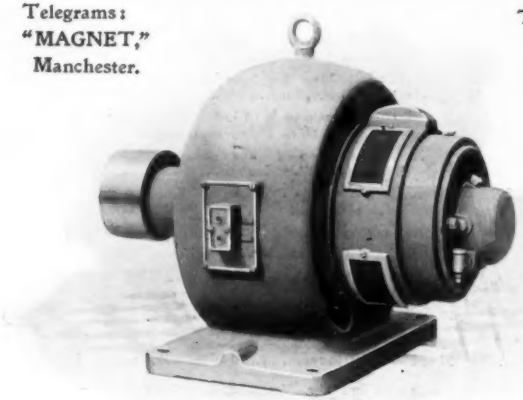

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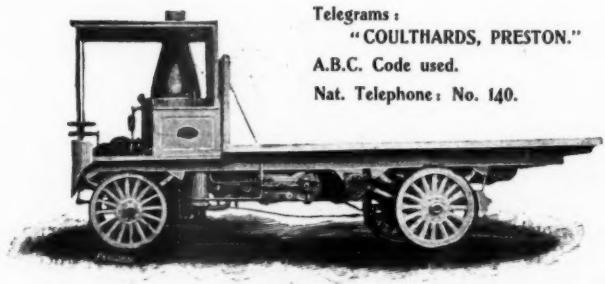

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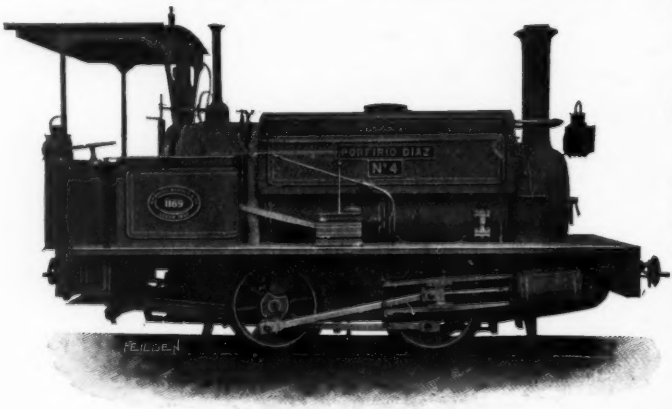

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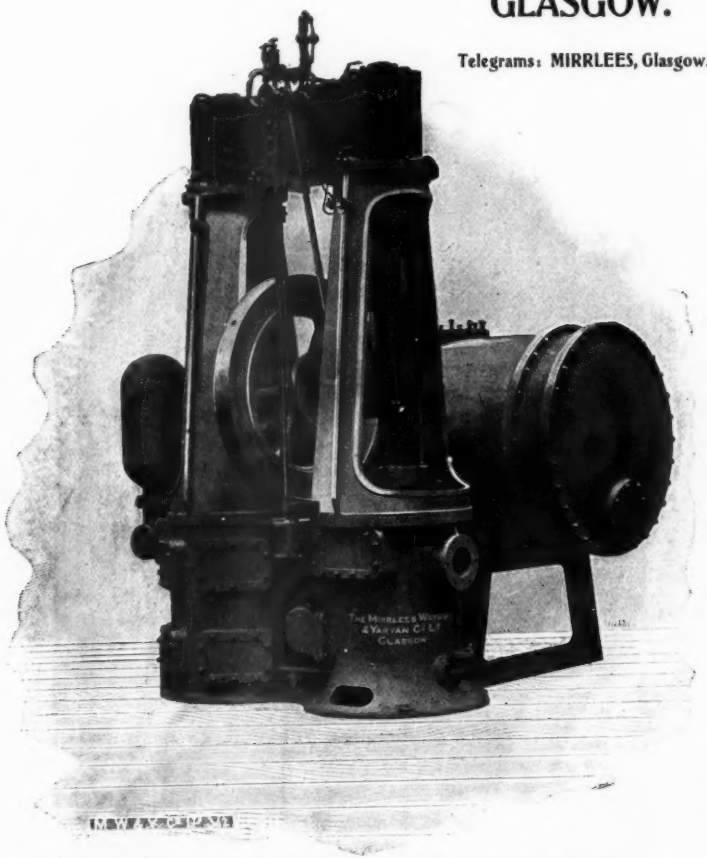

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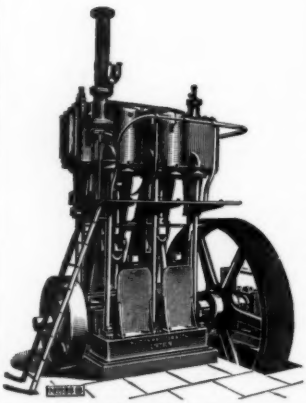

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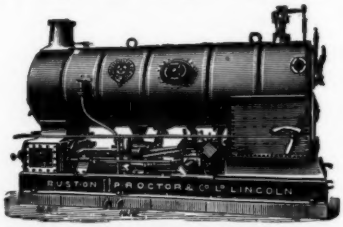

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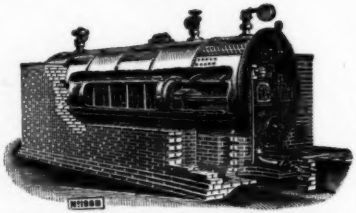

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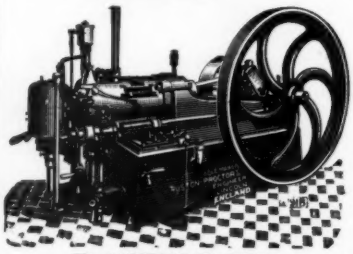

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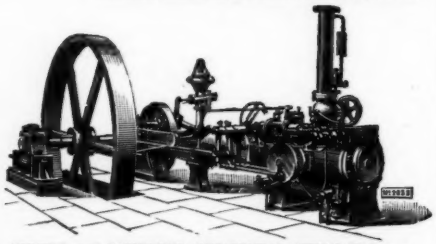

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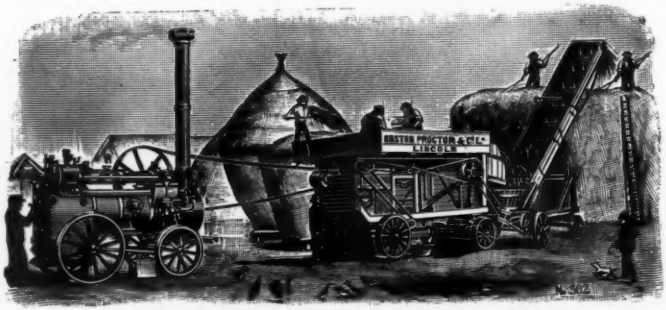

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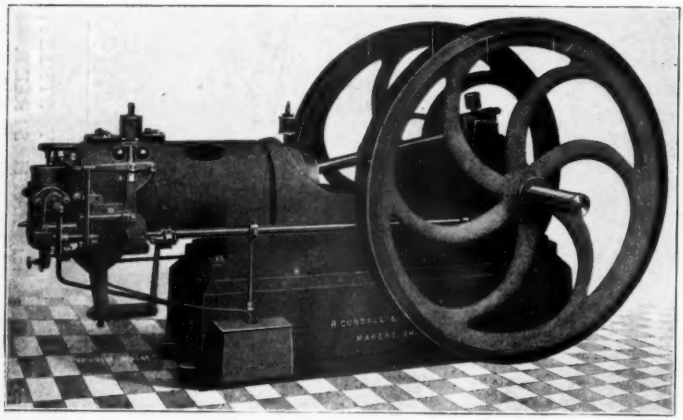

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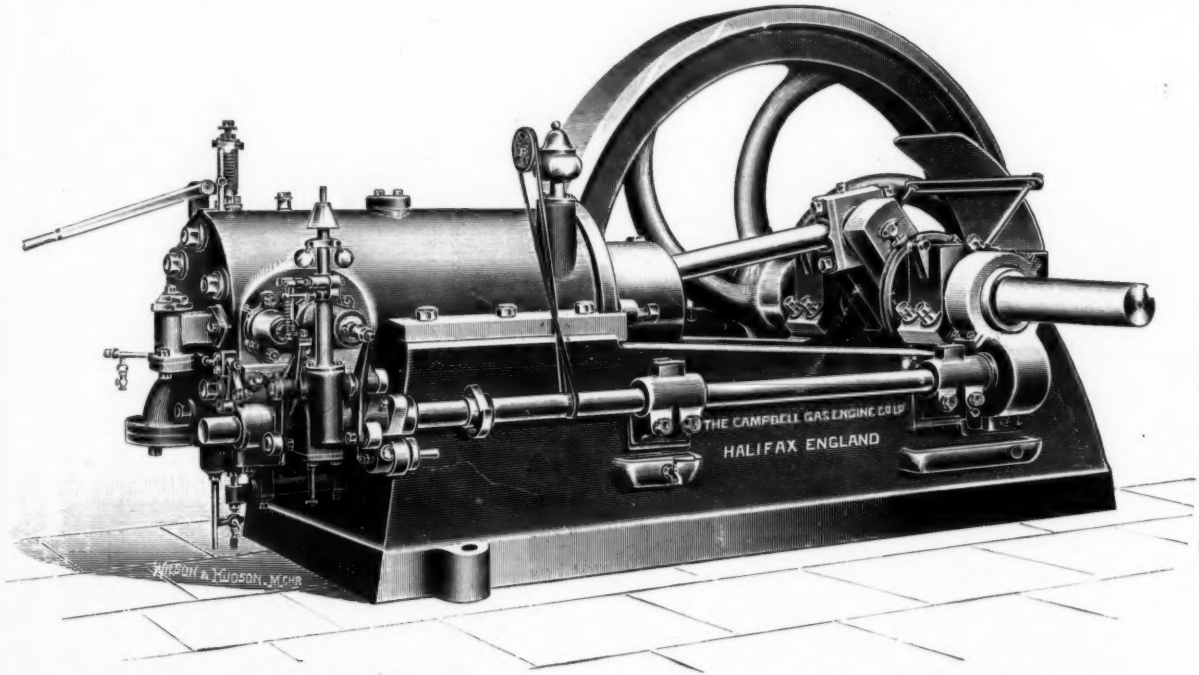

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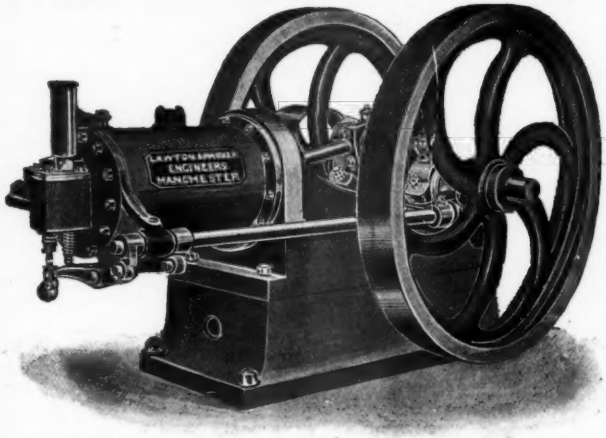

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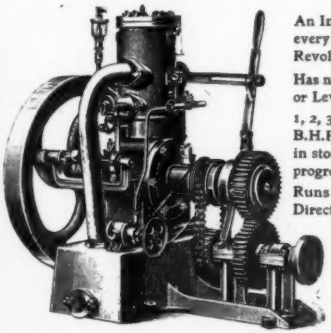

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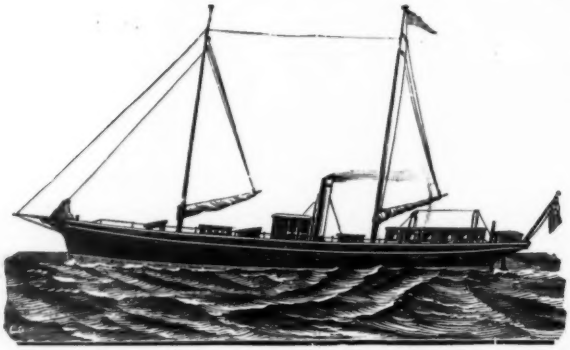

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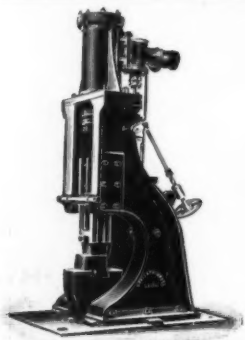

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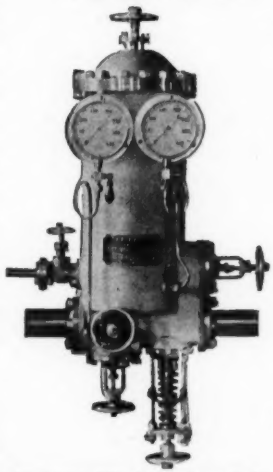

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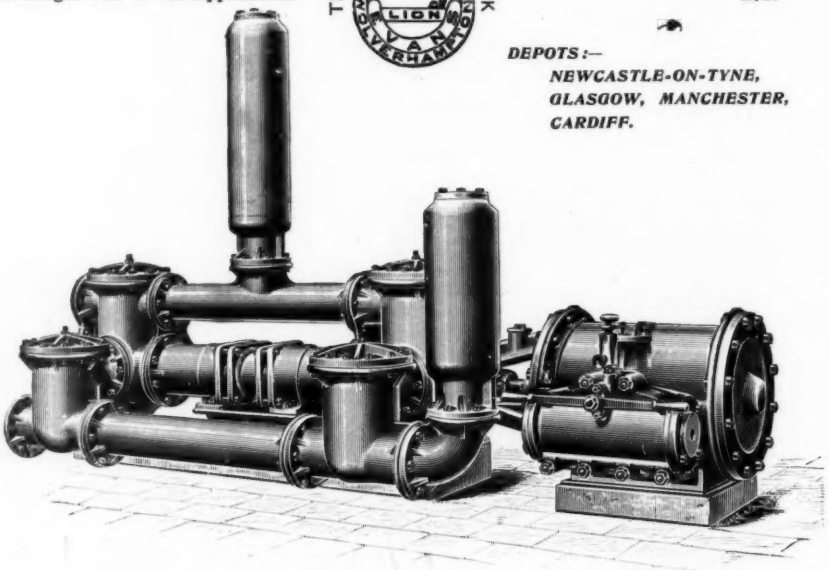

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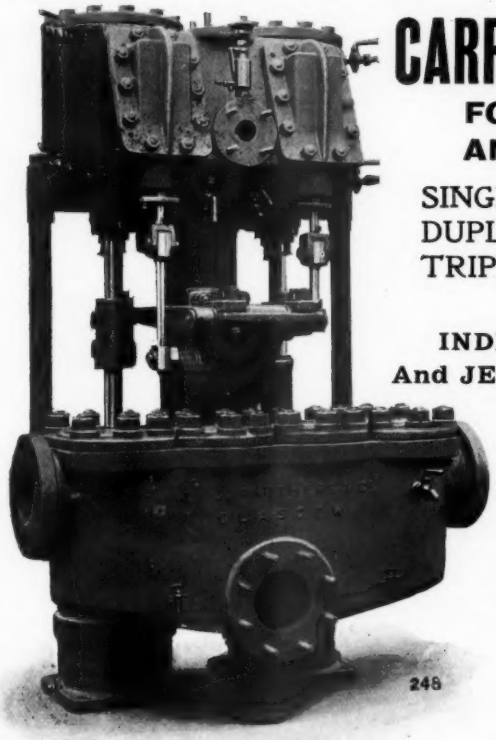

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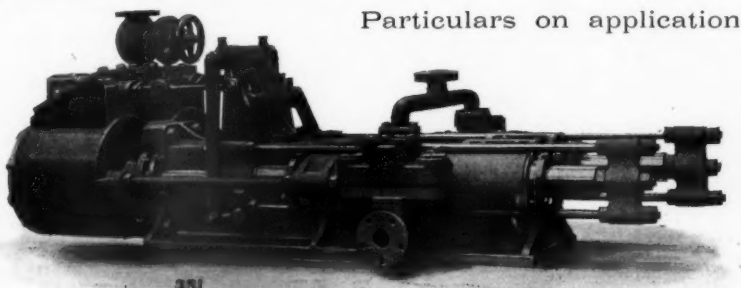

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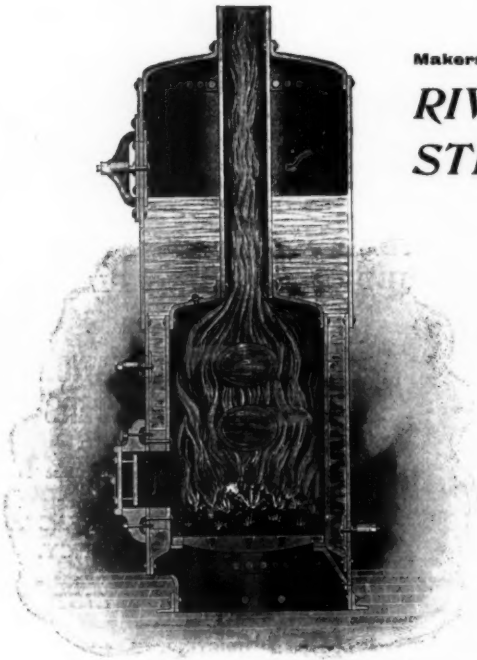

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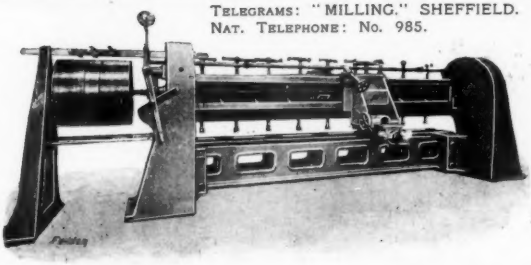

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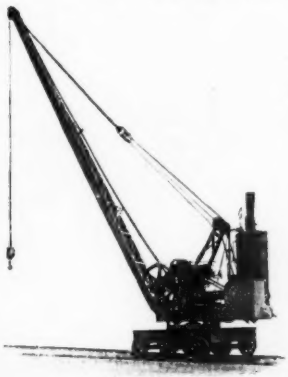

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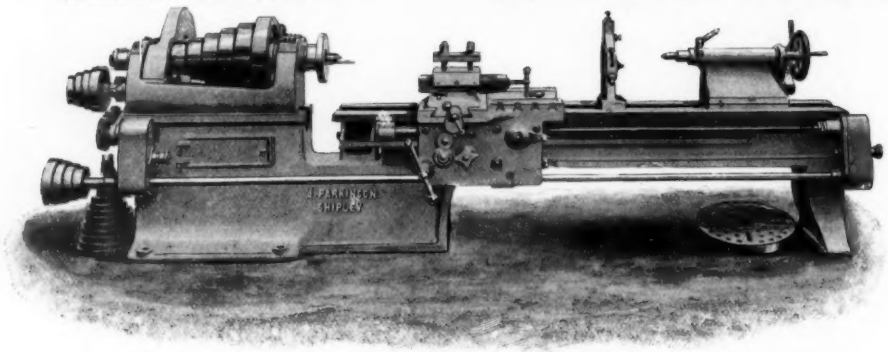

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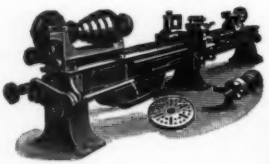

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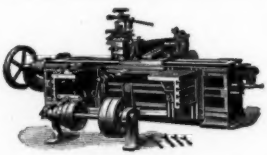

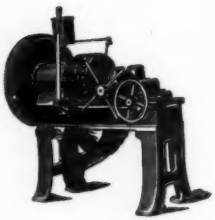

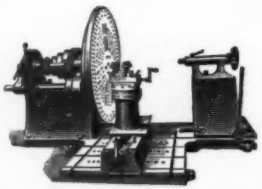

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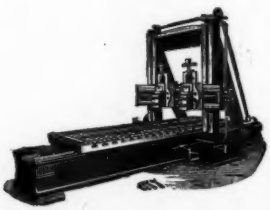

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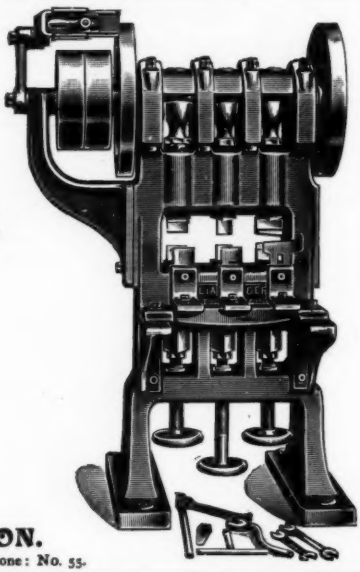

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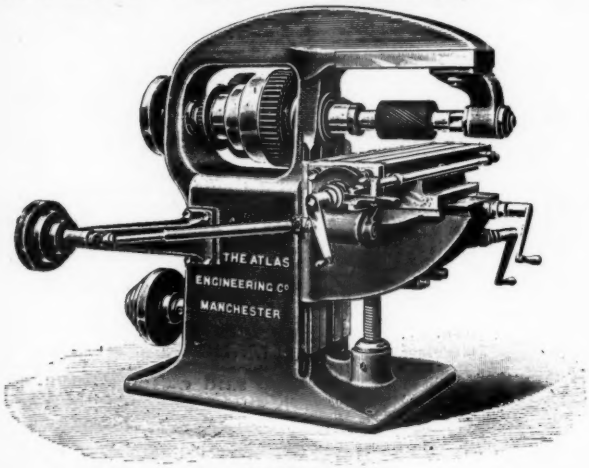

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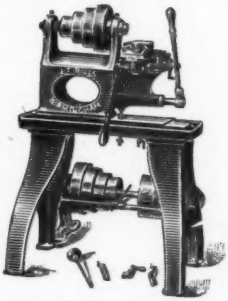

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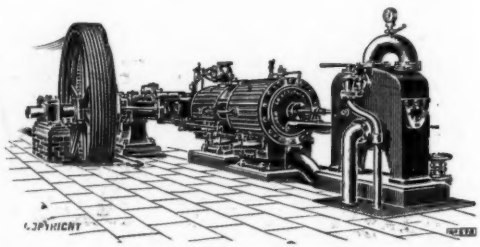

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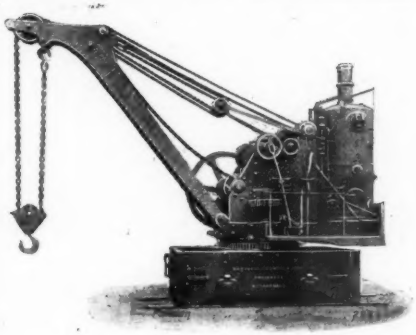

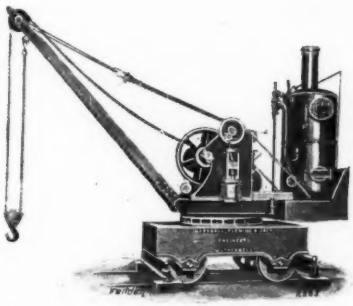

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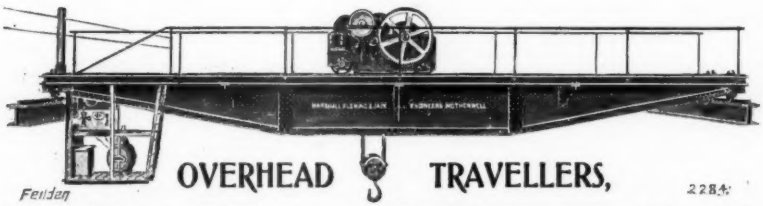

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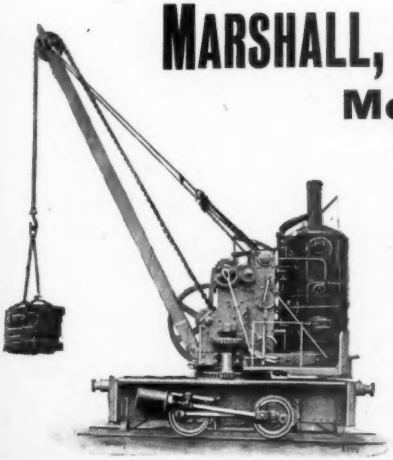

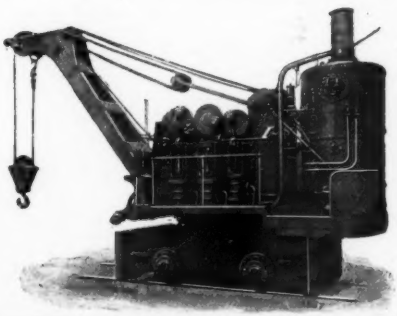

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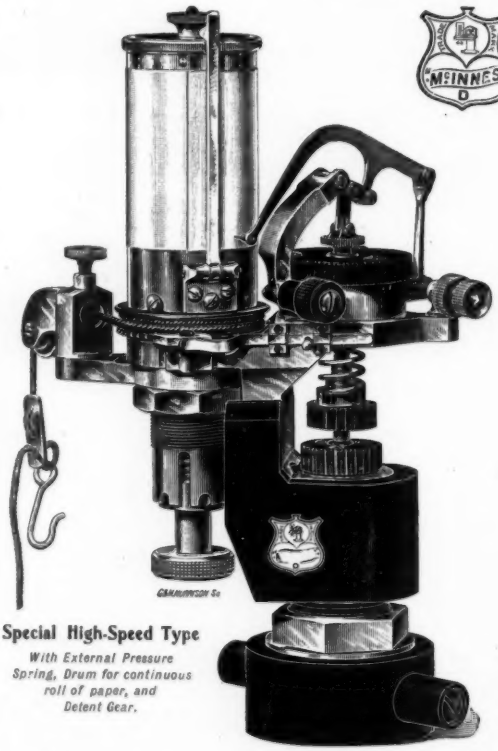

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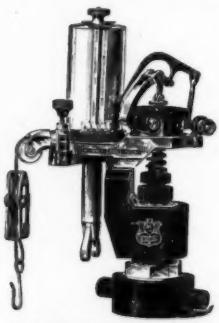

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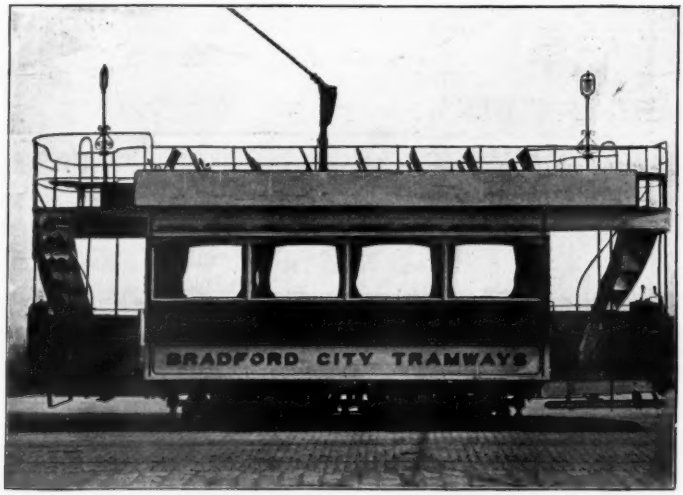

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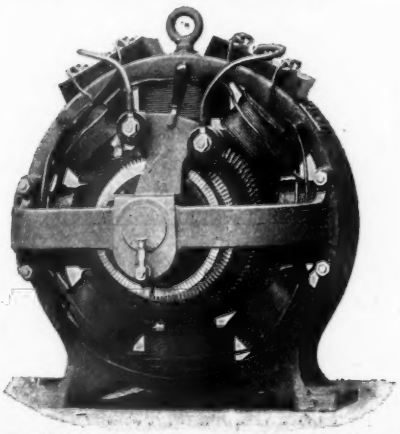

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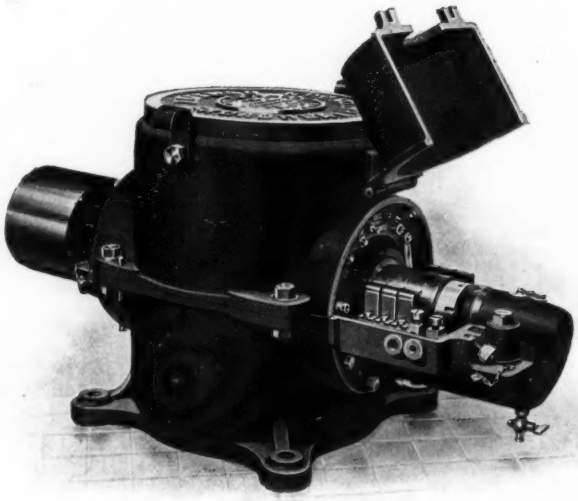

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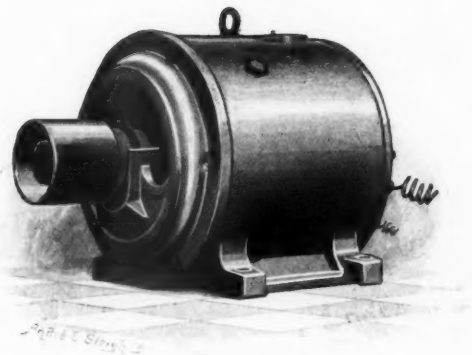

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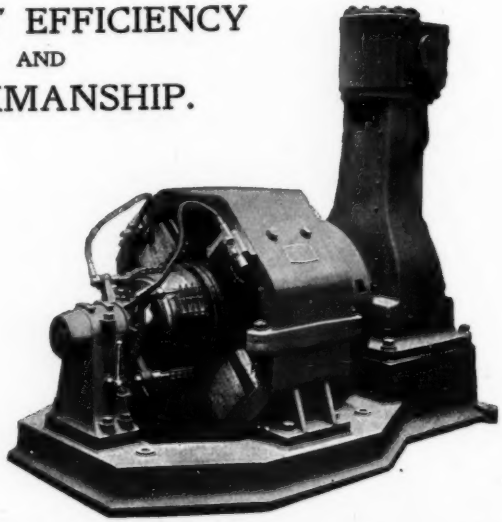

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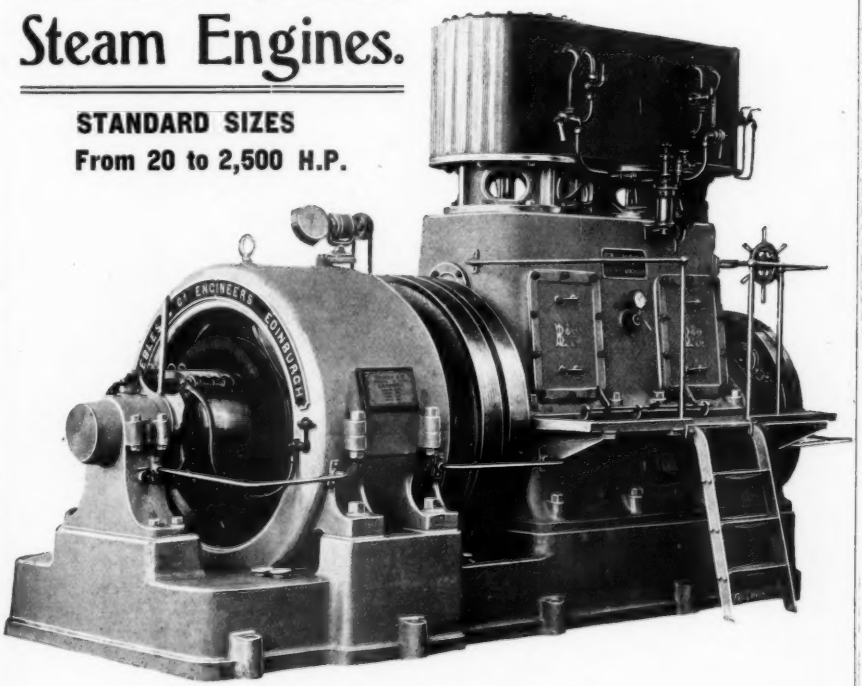

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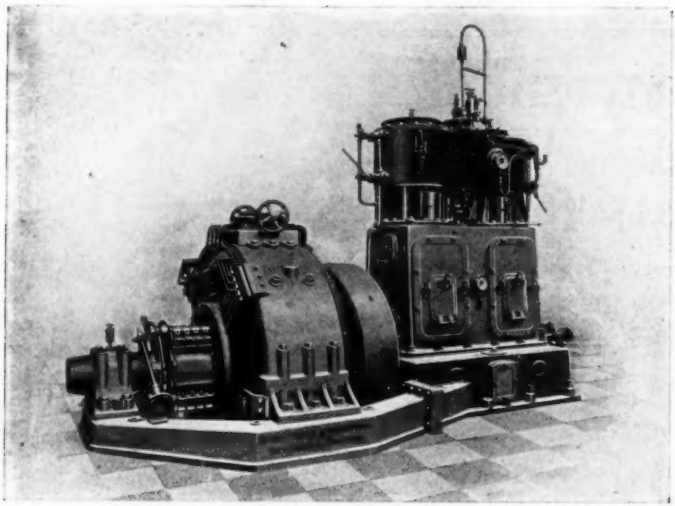

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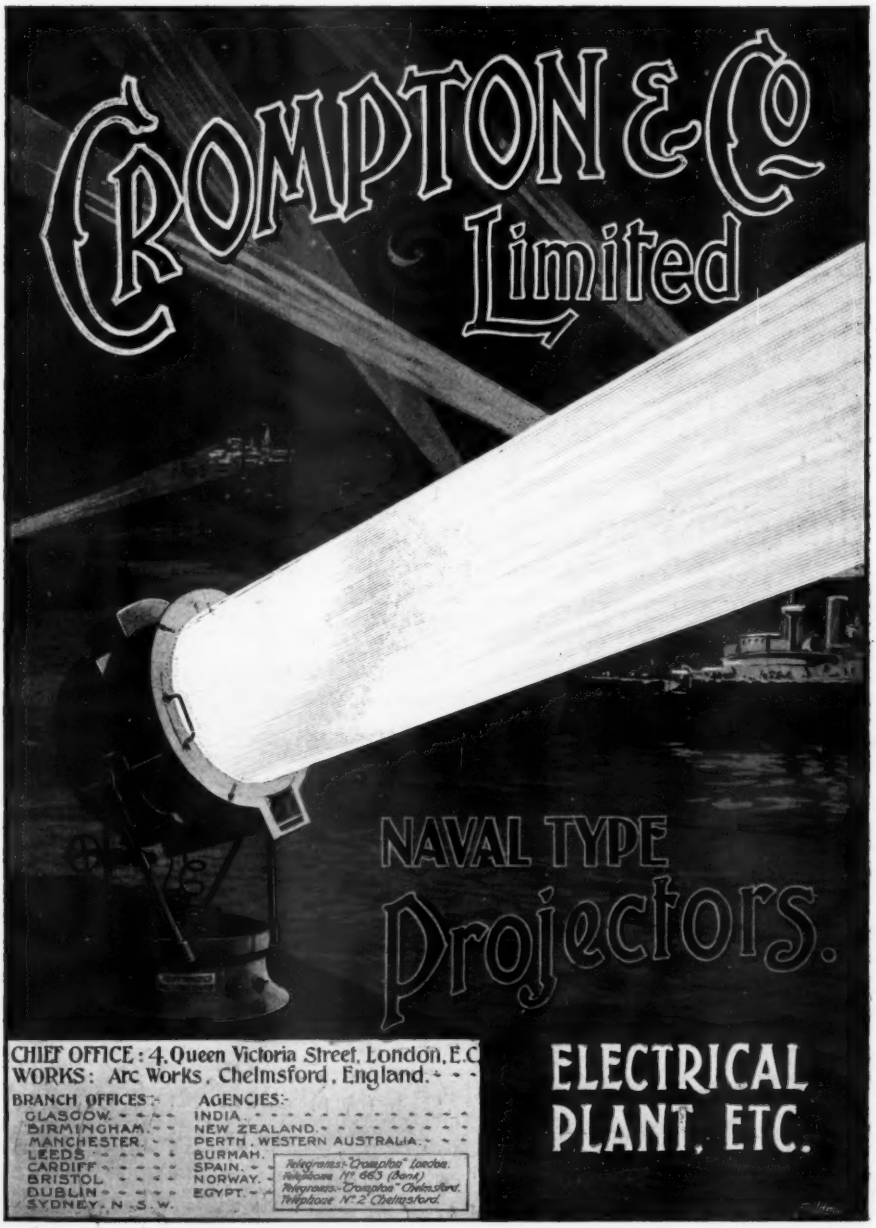
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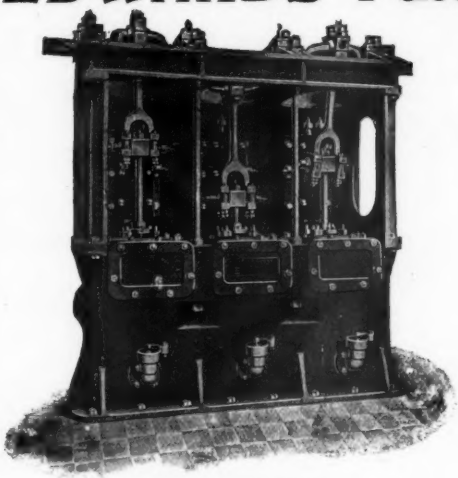

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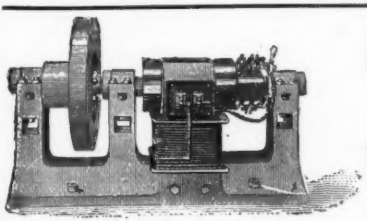

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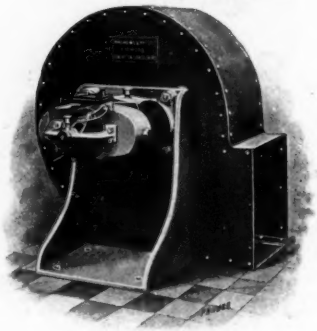

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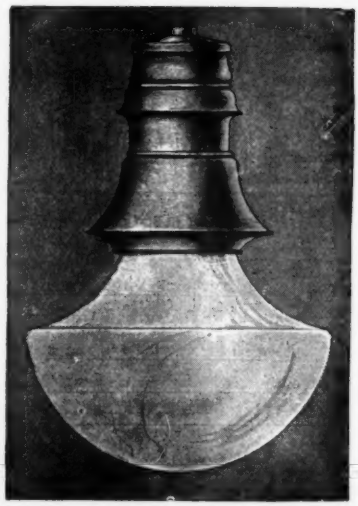

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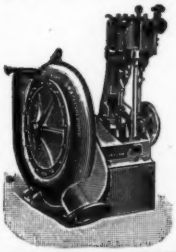

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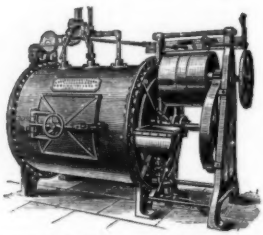

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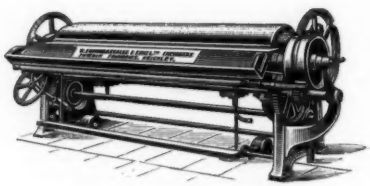

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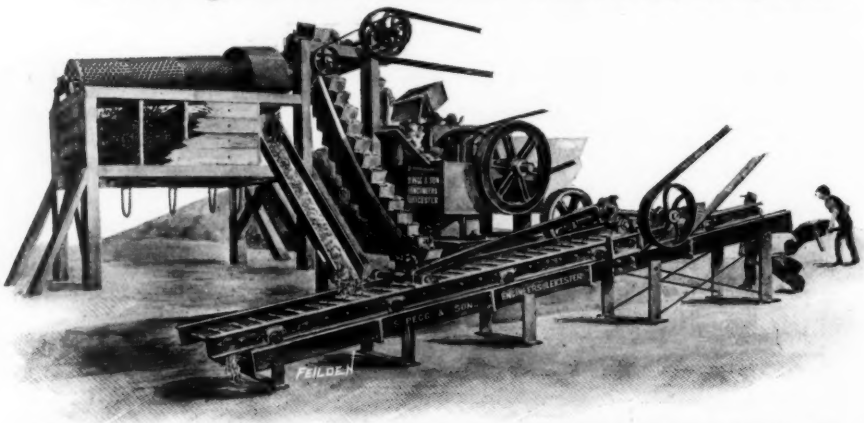

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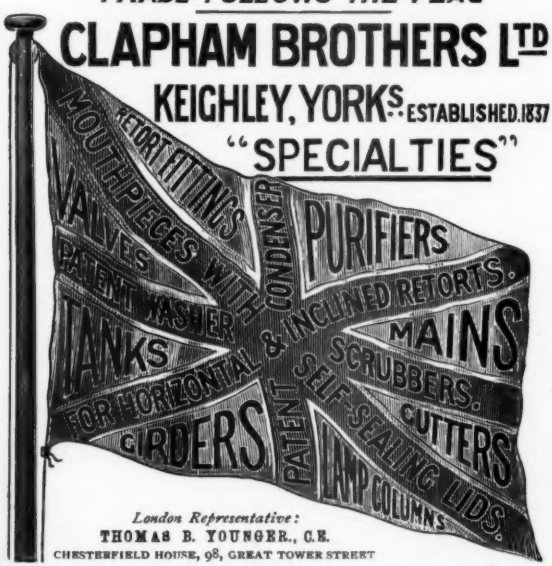

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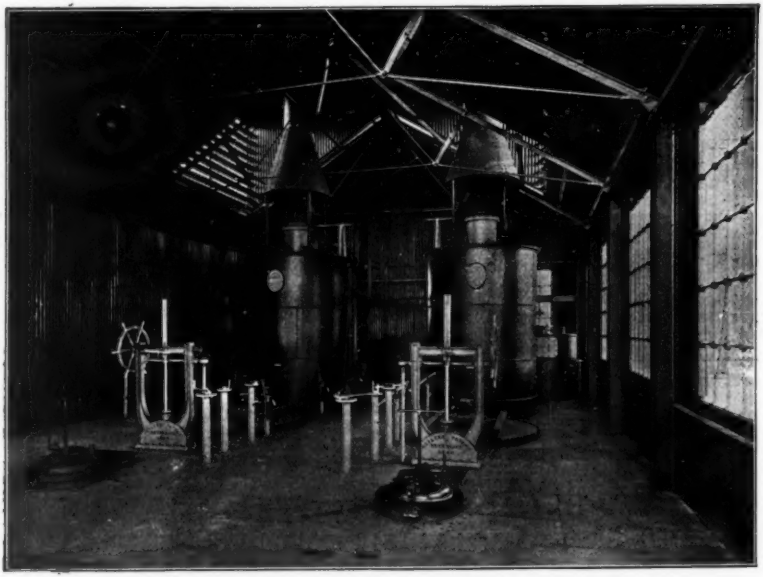

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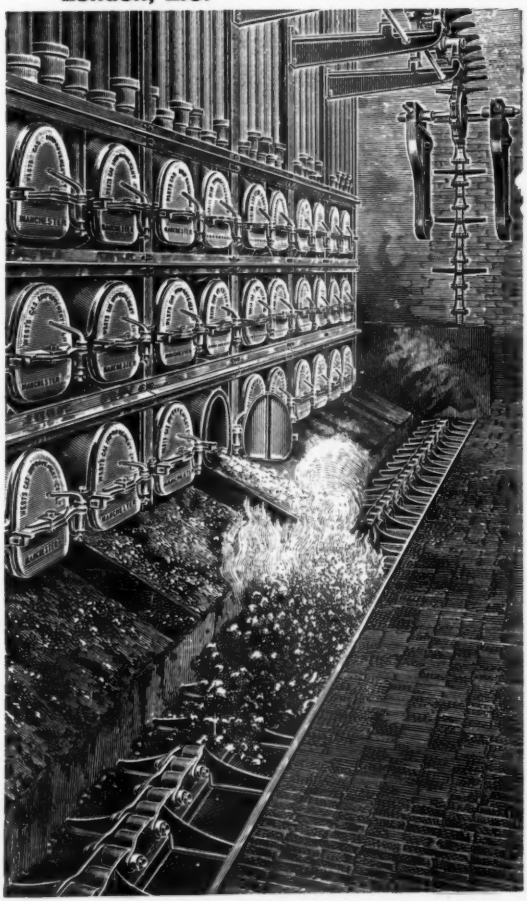

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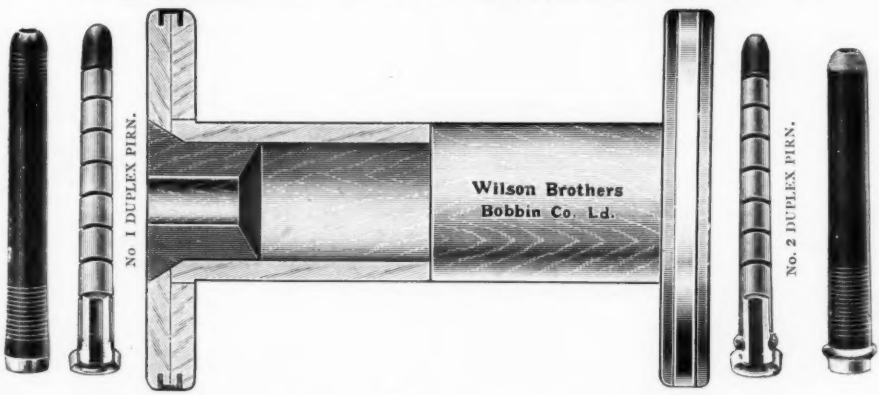

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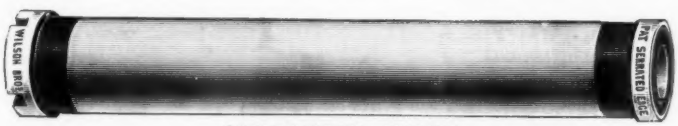

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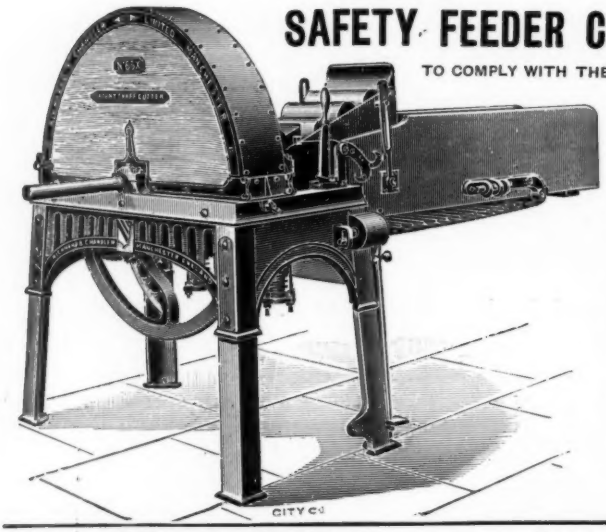

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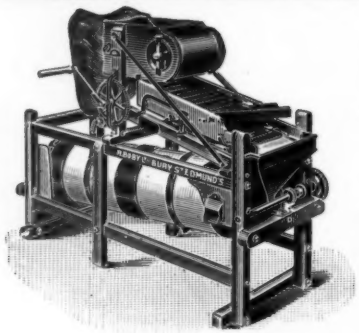

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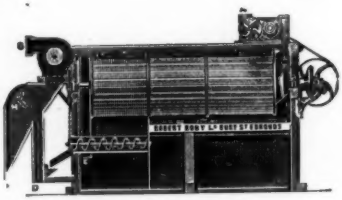

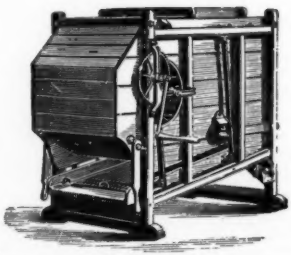

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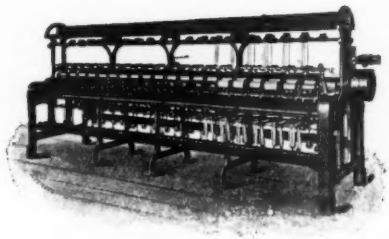

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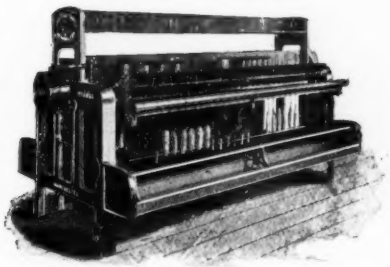

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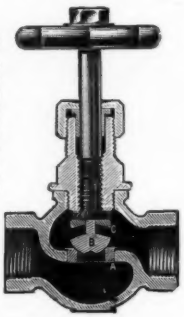

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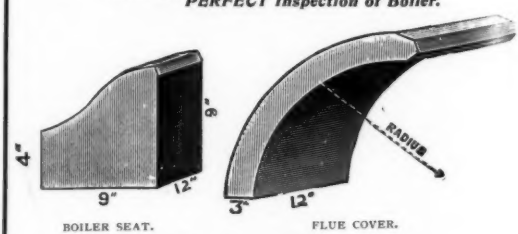

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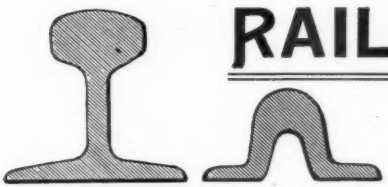

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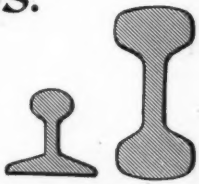

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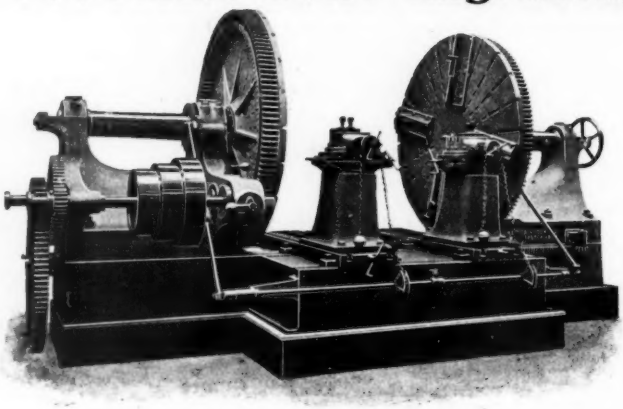

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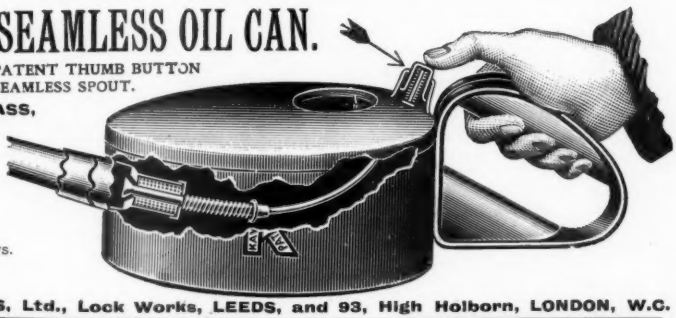

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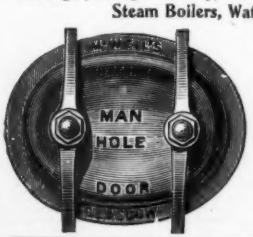

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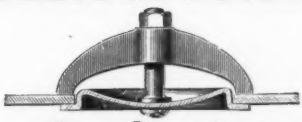

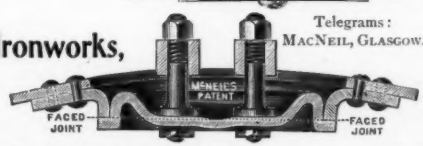

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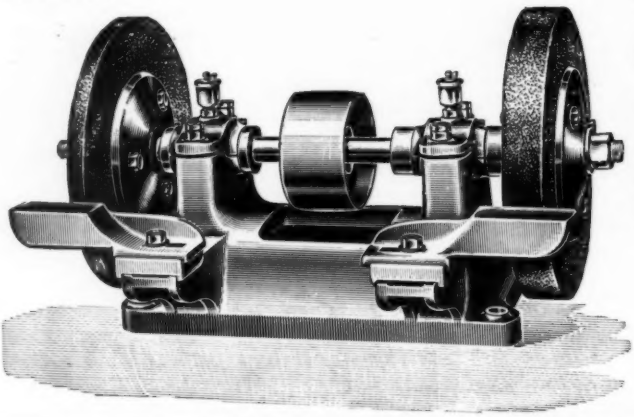

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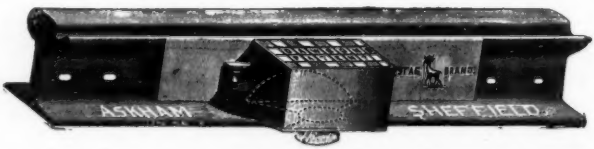

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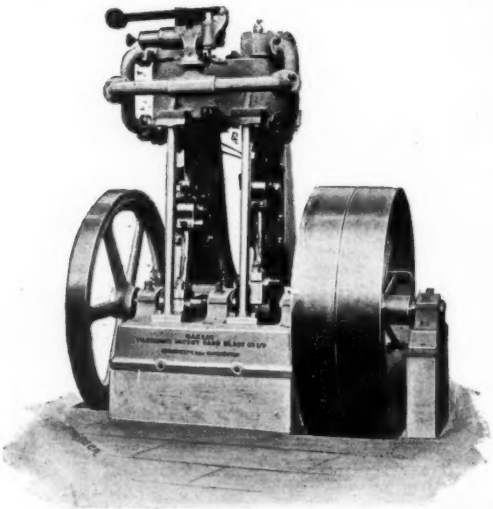

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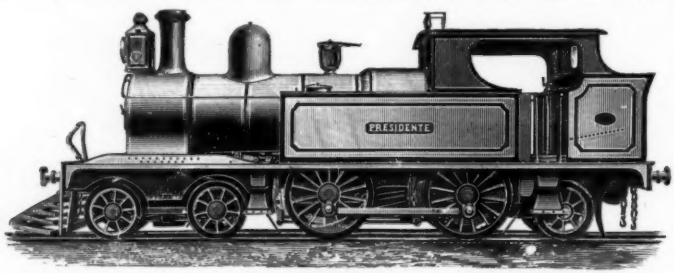

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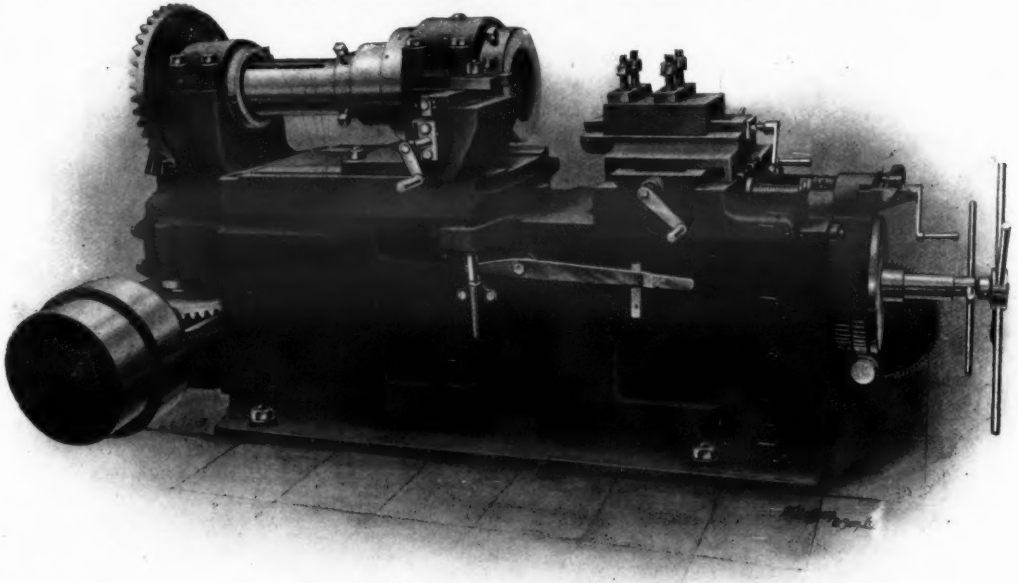

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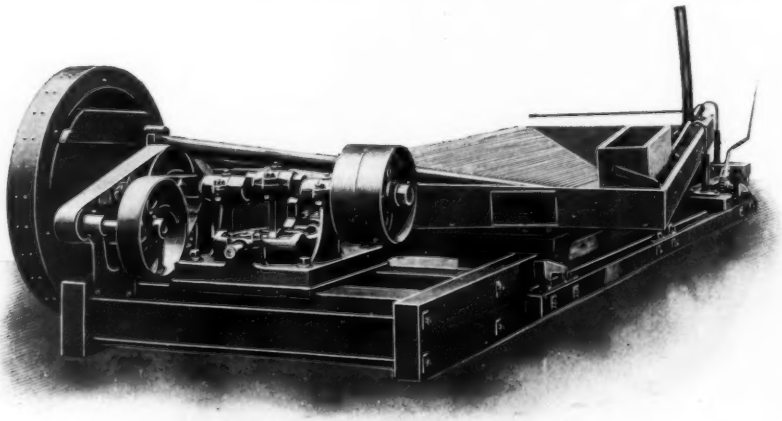

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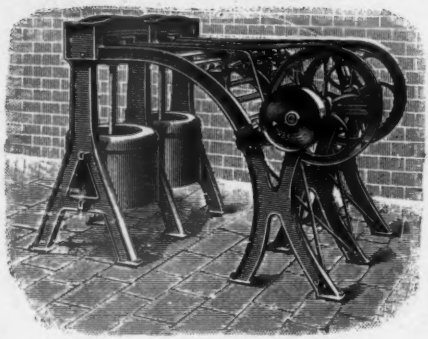

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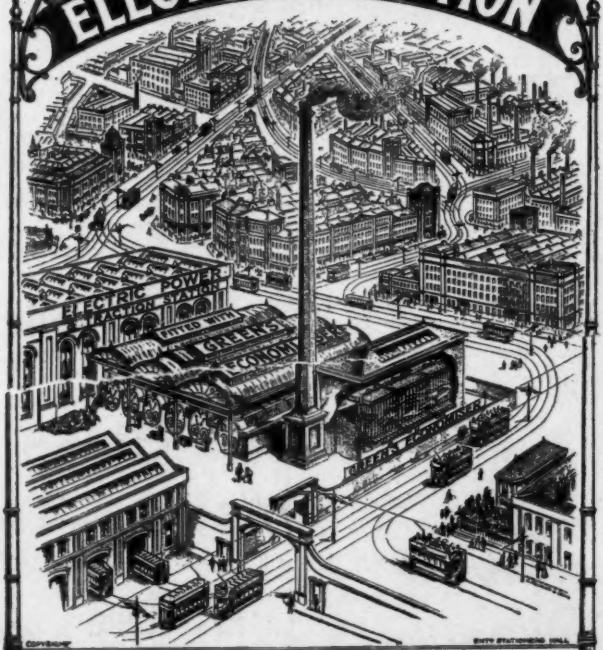

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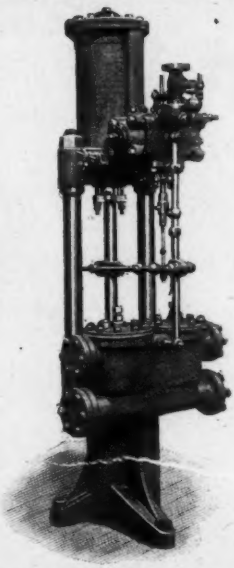

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